INSTRUCTIONS

MODEL 6030
EPUT® METER

Beckman®

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ELECTRONIC INSTRUMENTS DIVISION

of Beckman Instruments, Inc.
composed of the former Berkeley
Division and Offner Operations

FOLDER 13277

MODEL 6030
EPUT® METER

CONTENTS

Description Sheet

TIM Function Logic Diagram (C429014)

Model 6020 Instruction Manual

BECKMAN Instruments, Inc.
Electronic Instruments Division
2200 Wright Avenue
Richmond, California 94804

May 1966

MODEL 6030 EPUT® METER

GENERAL

The Model 6030 EPUT® Meter is identical to the Model 6020 EPUT Meter except that the COUNT function of Model 6020 is replaced by a Time Interval (TIM) function in the Model 6030.

The following description of the TIM function should replace the description of the COUNT function in the Model 6020 instruction manual.

TIM Feature TIM (X-Y)

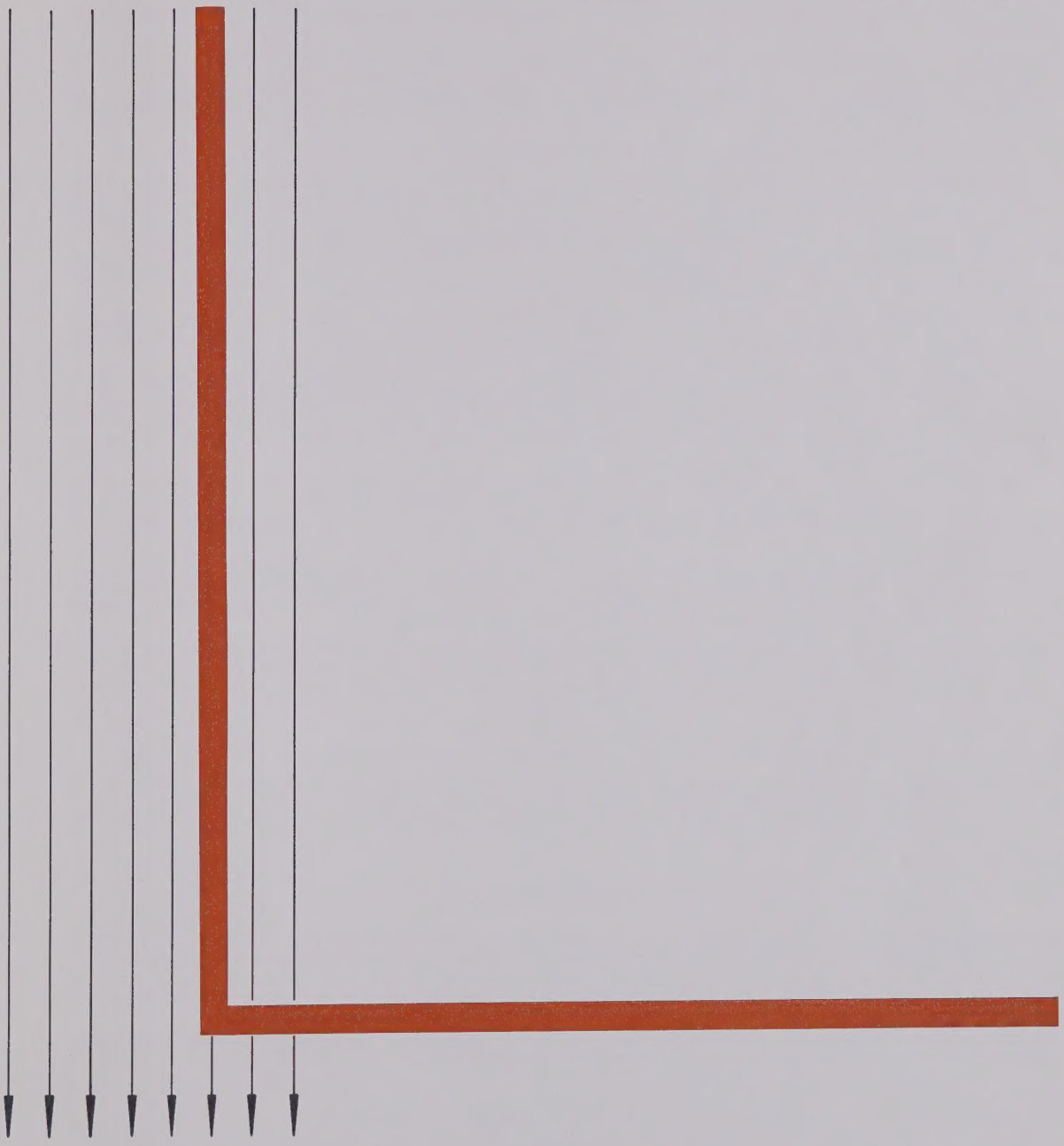
The Time Interval function of Model 6030 replaces the COUNT X/NM function of Model 6020. The TIM function is used to measure time intervals between an input X and an input Y. The first input X after reset starts the function, and the next input Y stops the function. The resolution of the TIM function is given by $N \cdot M \cdot 10^{-5}$. Thus, the maximum resolution is 10 microseconds and the minumum resolution is 100 seconds. With the resolution set to 100 seconds, the instrument is capable of measuring intervals up to 10^7 seconds.

The function table in the Model 6020 manual (page 2-3) should be changed by replacing COUNT (X/NM) with the following:

TIM (X-Y)	Measures the interval between events at X and Y in increments of $N \cdot M \cdot 10^{-5}$ seconds. The first input at X after reset triggers the count and the next input at Y stops the count. If N·M is set to 1, readout will display interval in tens of microseconds. If N·M is set to 10^7 (00000 x 100) the readout will display interval in hundreds of seconds.

INSTRUCTION MANUAL

MODEL 6020
PRESET EPUT®



Beckman® INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
2200 WRIGHT AVENUE
RICHMOND, CALIFORNIA • 94804

September 1965

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REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

MODEL 6020

Please make the following changes to the Parts List:

Page 5-1

Change CR3 from 775-815561 to 755-815561.

Page 5-19

Change description from "Crystal Socket" to "Fuse, Holder, Post Extractor".

MODEL 6020

Please note the following changes to the Model 6020 manual Parts List:

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
Page 5-2 - R14 and R15 should read:			
R14	601-015052	Resistor, F. Comp., 10k, 1/2W, 5%	1
R15	601-822324	Resistor, F. Comp., 10k, 1/4W, 5%	3
Page 5-12 - Add the following components (following CR17):			
Q1	755-425735	Transistor, Special	11
Q2 thru Q11		Same as Q1	
Q12	755-838105	Transistor, 2N3638	1
Q13	755-422494	Transistor, Special	1
Q14	755-424175	Transistor, Special	1
Page 5-12 - Add the following components (following R30):			
R31		Same as R19	
R32		Same as R30	
R33		Same as R5	
R34		Same as R1	
R35		Same as R23	
R36		Same as R41	
R37	601-822798	Resistor, 68k, 1/4W, 5%	2
R38	601-822299	Resistor, 6.8k, 1/4W, 5%	2
R39		Same as R38	
R40	601-823391	Resistor, 150Ω, 1/4W, 5%	1
R41	601-822324	Resistor, 10k, 1/4W, 5%	5
R42	601-823903	Resistor, 56k, 1/4W, 5%	3
R43 & R44		Same as R42	
R15		Same as R37	
R46 thru R48		Same as R41	
R49	601-822327	Resistor, 220Ω, 1/4W, 5%	1

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
R50	601-822527	Resistor, 1.5k, 1/4W, 5%	4
R51	601-024744	Resistor, 180Ω, 1/2W, 5%	1
R53 thru R55		Same as R5	

Page 5-13 - Add the following components (following CR9 & CR10):

Q1	755-425735	Transistor, Special	7
Q2 thru Q7		Same as Q1	

Page 5-14 - Add the following components (following R23):

R24		Same as R5	
R25		Same as R6	
R26	601-822369	Resistor, 680Ω, 1/4W, 5%	2
R27	601-823395	Resistor, 470Ω, 1/4W, 5%	1
R28	601-822527	Resistor, 1.5k, 1/4W, 5%	1
R29		Same as R26	

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COMPONENT LAYOUT DRAWINGS

Input Amplifier P.C. Board	C426372
Gate Control P.C. Board	D425446
Time Base Logic P.C. Board	C424721
Timing Control P.C. Board	D426251
Bi-Quinary DCU without Readout (Forward only)	C426107
Bi-Quinary DCU with Readout (Forward only)	C426103
Preset Output P.C. Board	C426432
"Count" Function P.C. Board	D425480
"Period" Function P.C. Board	D425481
"Ratio" Function P.C. Board	D425482
"Eput" Function P.C. Board	D425479
Outline Drawing	65-C-6020

DIAGRAMS

Input Amplifier Schematic	D426510
Gate Control Schematic	D425344
100 KC/1 MC Oscillator Schematic	C424009
Time Base Logic Schematic	B424591
Timing Control Schematic	D424590
Function Board Logic Elements Schematic	C425615
Preset Output Schematic	C426501
Bi-Quinary DCU, Forward Only, Schematic	D426100
"Count" Function Board Logic Diagram	C425620
"Period" Function Board Logic Diagram	C425618
"Ratio" Function Board Logic Diagram	C425619
"Eput" Function Board Logic Diagram	C425617
Power Supply Schematic	C423573
Remote Connector Wiring Diagram	D426584
BCD and Switch Strapping Wiring	D425276

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SECTION 1

INTRODUCTION

1.1 GENERAL

This instruction manual provides all the information required for the operation, basic understanding, and servicing of the Beckman 2 mc solid-state preset frequency counter.

The Model 6020 periodically takes measurements of frequency, period, and frequency ratio. It can also operate as a simple forward counter having an absolute storage capacity of 99,999.

In the REMOTE position, all functions can be controlled by an appropriate contact closure to ground on a rear panel remote connector.

A special feature of the Model 6020 is the built-in flexibility in the circuitry. Functions not specified on the front panel are, in most cases, easily achieved upon request by the customer.

The Model 6020 is especially useful as a frequency counter. Frequency is displayed in any units desired by simply preselecting the desired conversion factor.

1.2 SPECIFICATIONS

Specifications for the Model 6020 are given in Table 1-1.

Table 1-1. Specifications

Rate	DC to 2 mc.
Display	Five-digit edgelit with GATE OPEN indication.
Preset	Five thumbwheel switches for 5-digit PRESET N selection.

continued. . .

Table 1-1. Specifications - continued

Input Signal	Two channels, X and Y. Pulse width at least 0.5 μs. Pulse separation at least 0.5 μs. Sensitivity: 100 mv to 50 v.
Input Impedance	20,000 ohms at 100 mv.
Triggering Level	X and Y, both internal adjustments: ±10 v.
Slope Select	X and Y by contact closure to ground on remote connector.
Oscillator	Frequency: 100 kc. Stability: 3 parts in 10^7 per day at 25°C. ±1 part in 10^5 per day with ±10°C deviation from 25°C.
Data Storage	Visual storage; 1-2-4-8 BCD.
Operating Temperature	0 to 55°C.
Dimensions	3-1/2" x 19" x 17" HWD.
Weight	29 lbs.
Power	115/230 volts ±10%. 50/60 cycles, 60 watts.

1.3 OPTIONS

The options available to the standard instrument are listed in Table 1-2.

Table 1-2. Options

DE	Relay-rack slides. On request.
DH	230 V ac line voltage. Power transformer wired for 230 V, ±10%, 50 to 60 cycles.

continued. . .

Table 1-2. Options - continued

DM	Addition of sixth digit and OVERFLOW display.
DN	Remote display. Data output for remote display available at rear panel connector. Includes cover plate for vacated front panel display.
DQ	Tilt-foot handles to replace rack handle adapters.

SECTION 2

OPERATION

2.1 GENERAL

The Model 6020 accepts two inputs and can provide information on frequency and period. It can also operate as a forward counter. Figure 2-1 shows the front panel with readout display and front panel controls. X and Y input connectors are located on the rear panel as shown in Figure 2-2.

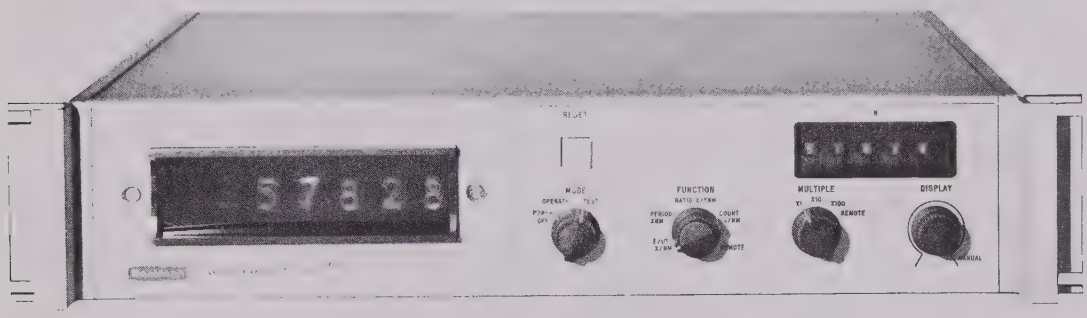


Fig. 2-1. Model 6020 Front Panel

2.2 APPLYING POWER

The instrument is ready to use as it arrives from the factory. To energize the unit, plug the power cord into a 117 v ac, 50-60 cycle source. The crystal oscillator circuit energizes immediately. Turn the MODE switch to OPERATE or TEST, energizing all circuits in the instrument.

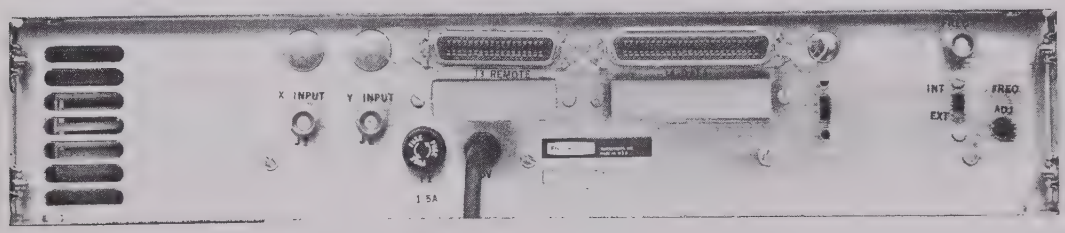


Fig. 2-2. Model 6020 Rear Panel

2.3 TYPES OF MEASUREMENTS

The Model 6020 has two input circuits, X and Y. The E/UT, PERIOD, and COUNT functions utilize only the X input. Operations performed by the instrument are described below.

2.3.1 Definition of Symbols

X refers to X input.

Y refers to Y input.

N refers to the 5-digit preset number.

M refers to the multiple factor indicated by the MULTIPLE switch: X1, X10, X100.

2.3.2 Measurements

The FUNCTION switch selects the operations performed by the instrument. The operation associated with each position is listed in Table 2-1.

Table 2-1. Types of Measurements

Function Position	Measurement
E/UT (X/NM)	Counts the number of X input occurring within (N·M) 10 microseconds. Readout displays number of events at X within this time interval. If N·M is set to 10^5 (1 second time base) readout will display frequency of X in cps. In general, frequency of X (cps) is obtained by dividing readout by (NM) 10^{-5} seconds.
PERIOD (XNM)	Measures the time required for NM events to occur at X. Readout displays time in 10's of microseconds. If X is periodic and NM is set to 10, readout will display period directly in microseconds. In general, average period (in seconds) is obtained by dividing readout by (N·M) 10^5.
RATIO (X/YNM)	Counts events occurring at X within the time required for N·M events to occur at Y. If

continued. . .

Table 2-1. Types of Measurements - continued

Function Position	Measurement
RATIO (X/YNM) continued	X and Y are both periodic and NM is set to a convenient multiple of 10, readout will display frequency ratio of X to Y multiplied by the selected multiple. In general, frequency ratio is obtained by dividing readout by NM.
~~COUNT (X/NM)~~ TIM(X-Y) SEE PAGE ONE FOR DESCRIPTION	Counts events at X in groups of NM. An output pulse is generated (Pin 8 on remote connector) each time the instrument has counted a multiple of NM. To stop counting, switch the FUNCTION selector to REMOTE. (Care must be taken to insure that Pins 10, 11, 12, 13 on remote connector are left open or else the instrument will continue to operate in one of the above modes.)
REMOTE	Operating mode is selected by grounding the proper pin on the remote connector. With the FUNCTION selector in this position, Pin 9 on remote connector becomes ground. FUNCTION is selected by connecting Pins 10, 11, 12 or 13 to Pin 9 (see Table 2-6 for remote connector pin numbering).

2.4 EXTERNAL CONTROLS AND CONNECTORS

Most operating controls are located on the front panel and are shown in Figure 2-1. X and Y input connectors (J1 and J2, respectively), remote connector (J3), and data output connector (J4) are located on the rear panel along with the oscillator adjustment and terminal. These are shown in Figure 2-2.

Each front panel control is explained in Table 2-2. Rear panel connectors and adjustments are explained in Table 2-3.

Table 2-2. Front Panel Controls

FUNCTION Selector	Each position is explained in Table 2-1.
5-Digit N-Select Switches	Selects the N preset number referred to on the FUNCTION selector.
MODE Selector	In the TEST or OPERATE positions, the instrument is energized. TEST: X and Y inputs are disabled and replaced by a 100kc test signal. Instrument operates on test signal according to mode indicated by FUNCTION selector. OPERATE: Instrument operates on X and Y inputs as indicated by the FUNCTION selector.
MULTIPLE Selector	Effectively multiplies N-preset by a factor of 1, 10 or 100. REMOTE position allows remote selection of multiple factor by an appropriate contact closure in the remote connector.
DISPLAY Control	Controls display time. With the control fully counter-clockwise, the instrument is set for minimum display time and maximum sampling rate. Turning the control clockwise extends display time and decreases sampling rate. In the MANUAL position, the instrument no longer recycles after the sampling interval and must be manually or remotely reset.

Table 2-3. Rear Panel Connectors and Adjustments

X and Y Inputs J1 and J2 respectively)	Data input connectors.
Remote Connector (J3)	Provides remote selection of slope, function and multiple. Provides remote

continued. . .

Table 2-3. Rear Panel Connectors and Adjustments - continued

Remote Connector (J3) continued	reset. Start, stop and preset outputs are off the remote connector. (Refer to Section 2.4.2.)
INT-EXT Switch	INT: Internal oscillator is used as time base and can be monitored at FREQ connector. EXT: Disconnects oscillator output; allows use of external time base.
FREQ. ADJ.	Used for fine adjustment of oscillator frequency.
FREQ. Connector (J5)	Performs either of two functions depending on position of INT-EXT switch. INT: Internal oscillator can be monitored at J5. EXT: An external signal can be applied at J5 to substitute for internal oscillator. External signal must be between dc and 1 mc and capable of producing 3 volts p-p across 3000 ohms.

2.4.1 Data Output Connector

This 50-pin socket is wired to the readout lines of each storage binary and provides positive true 1-2-4-8 binary coded decimal outputs to auxiliary equipment such as printer, display unit and data converter. Table 2-4 shows the binary code generated by the readout binaries representing each decimal digit. Table 2-5 lists connector pin numbering.

Positive true logic levels are: logic "0" = -10 volts or greater, logic "1" = -0.3 volt to ground.

Table 2-4. Four-Line Binary Code

Decimal Digit Registered	1st Binary (Wt. 1)	2nd Binary (Wt. 2)	3rd Binary (Wt. 4)	4th Binary (Wt. 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Table 2-5. Output Connector Pin Numbering

Displayed Decimal	1st Binary (Wt. 1)	2nd Binary (Wt. 2)	3rd Binary (Wt. 4)	4th Binary (Wt. 8)
10^0	Pin 1	Pin 2	Pin 26	Pin 27
10^1	Pin 3	Pin 4	Pin 28	Pin 29
10^2	Pin 5	Pin 6	Pin 30	Pin 31
10^3	Pin 7	Pin 8	Pin 32	Pin 33
10^4	Pin 9	Pin 10	Pin 34	Pin 35
10^5 (option)	Pin 11	Pin 12	Pin 36	Pin 37

Pin 25 - Inhibit Recycle. Carries an "inhibit recycle" command from the accessory to the instrument. When this pin is at ground, the instrument cannot recycle.

Pin 49 - Accessory Command, Carries a control signal from the instrument to the auxiliary recorder. This pin is negative (-10 volts or more negative) for 50 milliseconds and at approximately ground potential from the time of reset until the next accessory command.

Pin 50 - Ground.

2.4.2 REMOTE Connector (J3)

This is a 36-pin connector located on the rear panel which allows remote selection of slope, function and multiple. It also provides a means for remote reset. This is accomplished by having the specific front panel master control(s) in REMOTE and grounding the proper pin(s) on the remote connector. (See Table 2-6.)

The remote connector also provides outputs which indicate instants of start, stop, and NM. The last signal is most useful during the COUNT operation when an output pulse would be generated each time the instrument has counted a multiple of NM. Output pulses are approximately 200 nanoseconds and 10 volts positive true. Table 2-5 shows the function associated with each pin on the remote connector.

Table 2-6. Remote Connector Pin Numbering

Pin Number	Function	Pin Number	Function
1	X-Slope Select	19	Y-Slope Select
2	Ground	20	Ground
3	*	21	*
4	*	22	*
5	*	23	*
6	Start Output	24	Ground (twisted with 6)
7	Stop Output	25	Ground (twisted with 7)
8	Preset Output	26	Ground (twisted with 8)
9	FUNCTION Switch Remote Pos.	27	*
		28	*
10	RATIO	29	*
11	EPUT	30	*
12	~~COUNT~~ TIM.		
13	PERIOD	31	X1000
14	*	32	*
15	MULTIPLE Switch Remote Pos.	33	*
		34	*
16	X1		
17	X10	35	Ground
18	X100	36	Remote Reset

* Not used in standard instrument.

2.5 INTERNAL CONTROLS

2.5.1 Triggering Level Adjustment

The triggering level adjustment and test points are located on the amplifier boards and are accessible from the top of the instrument. There are two test points marked on the board: LEVEL and TEST. Voltage appearing at LEVEL is the actual triggering level, i.e., value which the input voltage must exceed in order to trigger the input circuit. Voltage appearing at TEST is the actual output from the amplifier. A simple adjustment procedure is outlined below.

1) Connect a voltmeter of at least 1% accuracy to the LEVEL test point and an oscilloscope to the TEST output.

2) Connect a signal generator to the amplifier input and set the rms voltage to the desired level using a 100kc signal.

3) Using the potentiometer mounted on the amplifier board, adjust the discriminator desired sensitivity. Maximum sensitivity is indicated by the appearance of an output pulse train with approximately 50% duty cycle.

4) The actual triggering level (plus hysteresis) is indicated by the dc voltmeter. A reading of approximately 0 volts indicates maximum sensitivity.

2.5.2 Slope Selection

The slope control is a contact closure to ground on the remote connector (pin 1 for X and 19 for Y). It determines which slope, positive or negative, of the input signal will trigger an output pulse. Figure 3-4 in Section 3 shows the voltage discriminator output with a sine wave input, and the effect of + and - slope switch positions.

The slope selection procedure is as follows:

1) For positive (+) slope triggering, pin 1 or 19 (X or Y input, respectively) on the remote connector (J3) is left open circuited.

2) For negative (-) slope triggering, the pin is grounded.

2.6 TEST OPERATION

The TEST position of the MODE selector provides a quick, uncomplicated method of checking the instrument for proper operation. A simple test procedure is outlined as follows:

1) Set MODE switch to TEST.

2) Set DISPLAY to an intermediate position.

3) Set NM to any arbitrary number.

4) Set FUNCTION to EPUT. Display should latch on NM.

5) When FUNCTION is switched to PERIOD or RATIO, display should latch on NM.

6) Set FUNCTION selector to COUNT X/NM and NM = 100,000.

7) Press the RESET button. Display should follow and update at a rate of 1 count per second. With NM = 500,000, display should follow and update at the rate of 1 count per five seconds.

SECTION 3

GENERAL OPERATING THEORY

3.1 GENERAL

This section describes the basic operating theory of the Model 6020. Information in this section is primarily from a functional approach and minimizes any detailed description of circuit operation.

Logic symbols are defined in the Appendix and are listed along with typical circuits.

A block diagram of printed circuit boards in the Model 6020 is shown in Figure 3-1, a fold-out page at the end of this section.

3.2 TIMING SEQUENCE

As shown in Figure 3-2, the operations within the Model 6020 follow this sequence:

1) Reset.
2) Start count.
3) Stop count.
4) Transfer data to readout.
5) Display stored data.
6) Automatic reset and recycle.

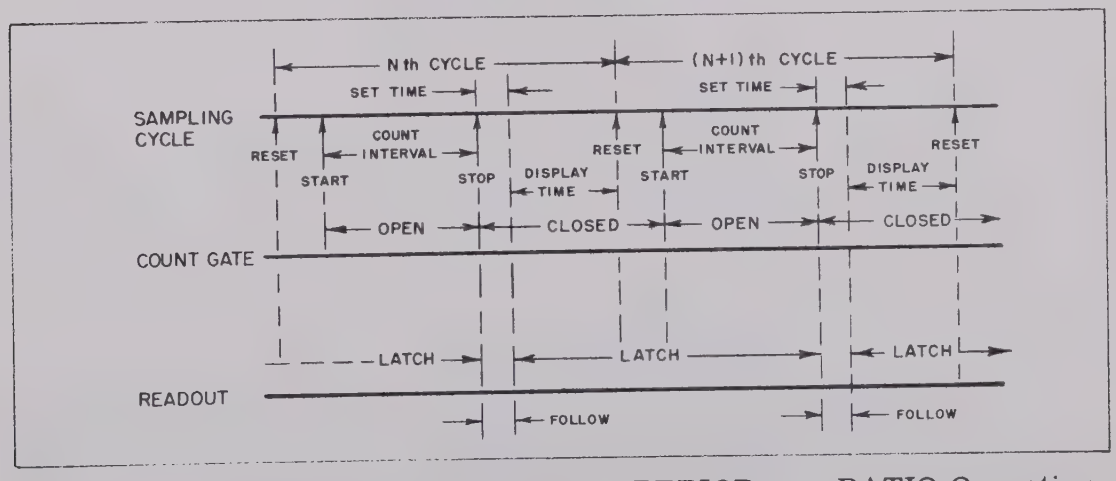


Fig. 3-2. Timing Diagram for EPUT, PERIOD, or RATIO Operation. In COUNT instrument does not recycle, count gate remains open, and display follows readout DCU's.

3.2.1 Reset

The instrument can be reset manually local or remote, or automatically by the display timer at the end of display time.

3.2.2 Start Pulse

The "start" pulse opens the count gates to the decimal counting units. It is triggered in the following ways, depending on the function.

1) In EPUT: on the following clock pulse.
2) In PERIOD: on the following X input.
3) In RATIO: on the following Y input.
4) In COUNT: on the following clock pulse.

3.2.3 Stop Pulse

The "stop" pulse closes the count gates to the decimal counting units. It occurs under the following conditions after the N and M DCU's reach preset N and M, respectively:

1) In EPUT: on the following clock pulse.
2) In PERIOD: on the following X input.
3) In RATIO: on the following Y input.
4) In COUNT: the count gate remains open.

3.2.4 Count Interval

The count interval between start and stop pulses depends on the X and Y input frequencies and N and M settings. When the FUNCTION switch is in COUNT, the interval has an indefinite duration because the count gate remains open.

3.2.5 Set Time

The "set", or transfer to storage time, is approximately 1 millisecond in the standard instrument. During this interval, the display is in the "follow" mode; that is, information in the readout DCU's is transferred to storage. It remains stored until the next "set" interval. During this time, it follows and stores the new readout.

3.2.6 Display Time

Display time is the time interval during which stored data is available to accessory equipment for recording.

The front panel DISPLAY control serves to alter the time constant of the display circuit on the Timing Control Board. The display interval is adjustable between approximately 0.1 second and 10 seconds.

3.3 EPUT (X/NM) OPERATION

1) The FUNCTION selector in EPUT opens a set of logic gates on the EPUT Function Board.
2) Count gate opens on the following clock pulse.
3) Readout DCU's count every X input while the gate is open.
4) M DCU's count every clock pulse.
5) Preset N DCU's count once each time the M DCU's reach M.
6) When the preset N DCU's reach N preset and the M DCU's reach M-1, the "stop" gate is controlled open for the next clock pulse, which serves to close the count gates.
7) Therefore, the readout DCU's have counted the number of events at X during a (N· M) 10 microsecond interval.

3.4 PERIOD (XNM) OPERATION

1) The FUNCTION selector in PERIOD opens a set of logic gates on the PERIOD Function Board.
2) Count gate opens on the following X input.
3) Readout DCU's accumulate every clock pulse.
4) M DCU's accumulate every X input.
5) Preset N DCU's count once each time the M DCU's reach M.
6) When M and N DCU's reach M-1 and N-preset, respectively, the stop gate is controlled open for the next X input, which closes the count gate.
7) The readout displays the time in 10's of microseconds required to receive N· M X inputs.

3.5 RATIO X/YNM OPERATION

1) The FUNCTION selector opens a set of logic gates on the Ratio X/YNM Function Board.
2) Count gate opens on the following clock pulse.
3) Readout DCU's accumulate every X input.
4) M DCU's accumulate every Y input.
5) Preset N DCU's count once each time the M DCU's reach M.
6) When M and N DCU's reach M-1 and N-preset, respectively, the stop gate is controlled open for the next Y input which closes the count gate.
7) The readout displays the number of events at X during the interval required for N·M events at Y.

3.6 COUNT (X/NM) OPERATION BNC

1) The FUNCTION switch in COUNT opens a set of logic gates on the Count X/NM Function Board.
2) A signal from the Function Board goes to circuitry in the Timing Control Board and causes the readout control lines to assume the "follow" condition.
3) Count gate opens on the next clock pulse.
4) M DCU's accumulated every X input.
5) Preset N DCU's accumulate once each time the M DCU's reach M-1.
6) Readout DCU's count once each time the M and N DCU's reach M-1 and preset N-1, respectively.
7) Readout displays the number of groups of N·M events at X.

3.7 PRESET/OUTPUT BOARD

The Preset/Output Board contains three single-shot circuits which provide outputs to accessory recording instruments. Pulses on the three output lines indicate one of the following:

a) Instant when the count gate is opened.
b) Instant when the count gate is closed.
c) Instants when the instrument has counted a multiple of NM bits of data.

The last condition (c) is especially useful when the instrument is operating as a simple counter.

These signals appear on pins 6, 7, and 8, respectively, on the remote connector. Each single-shot generates a positive true pulse, (-10 volts to ground) approximately 200 nanoseconds wide.

3.8 INPUT AMPLIFIERS

The input amplifiers consist of a discriminator-amplifier input circuit followed by slope selection logic.

The input circuit is a differential amplifier using regenerative positive feedback. The use of such feedback and dc switching levels insures the fast switching time which is essential in high frequency applications.

The slope selection logic permits triggering on either the positive or negative slopes of the input signal. An input to the discriminator circuit generates a 0.6 volt p-p positive true signal to the slope selection circuitry and appears at the amplifier output as a positive true pulse (-7 v to ground). If a positive slope is selected, the output is triggered by the leading edge of the discriminator output; whereas, if a negative slope is selected, the output is triggered by the trailing edge. Figure 3-3 gives the slope selection logic. Figure 3-4 shows the result of amplifier discrimination and slope selection.

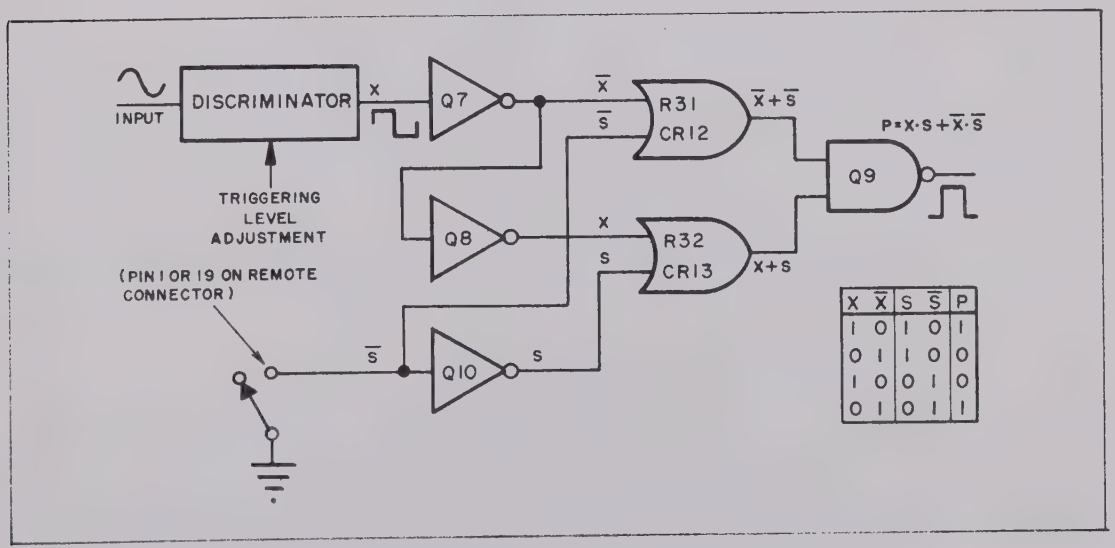


Fig. 3-3. Slope Selection Logic Diagram

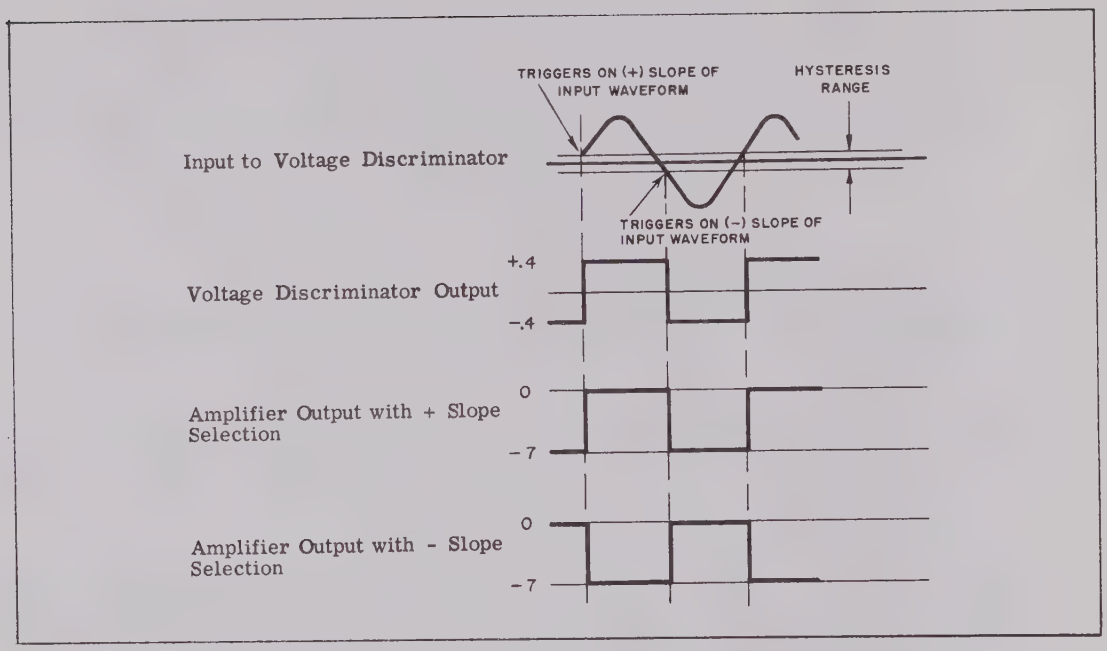


Fig. 3-4. Amplifier Input and Output Signals

3.9 FUNCTION BOARDS

3.9.1 General Theory of Operation

Each of the four Function Boards perform as basic logic gates. The start, stop, accumulate N·M and readout pulses all originate from one of the four logic boards, depending on the function selected. Each board selects the specific conditions under which each of the five above mentioned pulses are generated.

Auxiliary inputs and outputs to and from each board allow for flexibility in the functions performed by the instrument.

3.9.2 EPUT and PERIOD Functions

Figures 3-5 and 3-6 show the basic logic diagram for the EPUT and Period XNM Function Boards, respectively. With the FUNCTION selector in EPUT or PERIOD, the start, accumulate M, and readout gates are controlled open. The stop gate is controlled open when the N and M DCU's have accumulated N-1 and M-1 events, respectively. The

accumulate N gate is controlled open each time the M DCU's have accumulated M-1 events. Outputs to the Gate Control Board are then triggered by clock or X input pulses which occur immediately after the gates are controlled open.

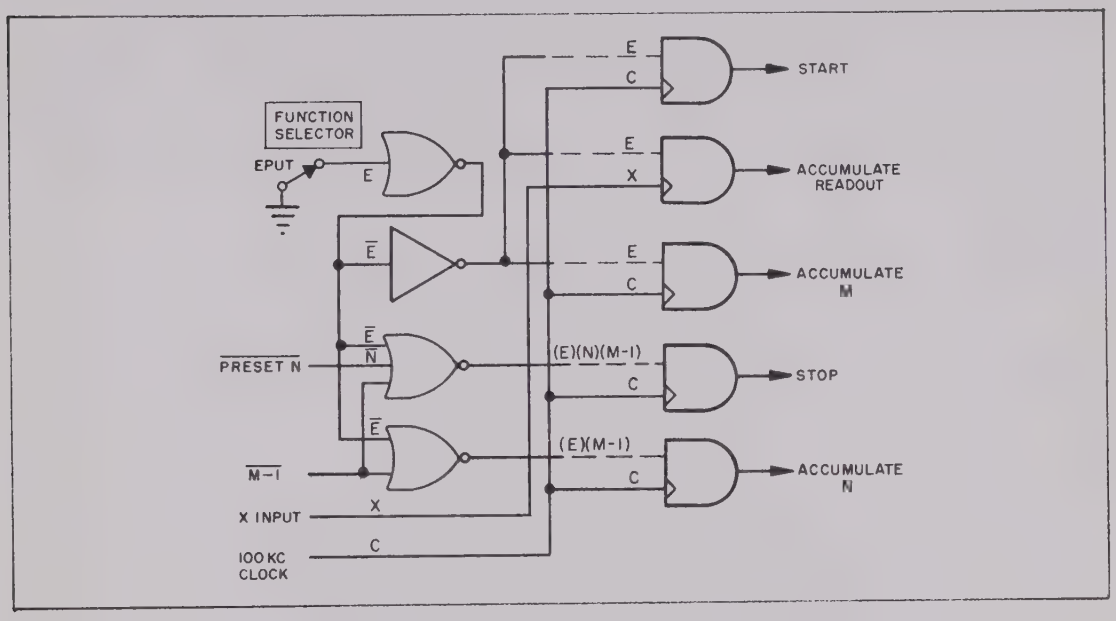


Fig. 3-5. Basic EPUT Logic

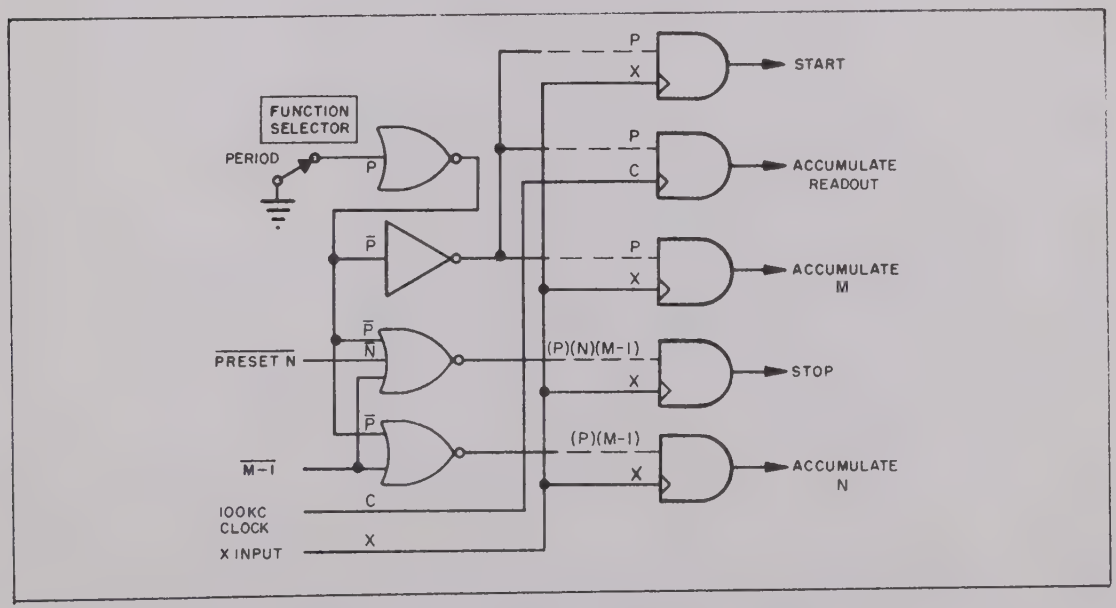


Fig. 3-6. Basic PERIOD Logic

3.9.3 RATIO Function

Figure 3-7 shows the basic logic diagram for the RATIO Function Board. With the FUNCTION selector in RATIO, the start, accumulate readout and accumulate M gates are controlled open. The stop gate is controlled open when the N and M DCU's have accumulated preset N and M-1 events, respectively. The accumulate N gate is controlled open each time the M DCU's reach M-1. Outputs to the Gate Control Board are then triggered by X or Y input pulses occurring at the next instant of time.

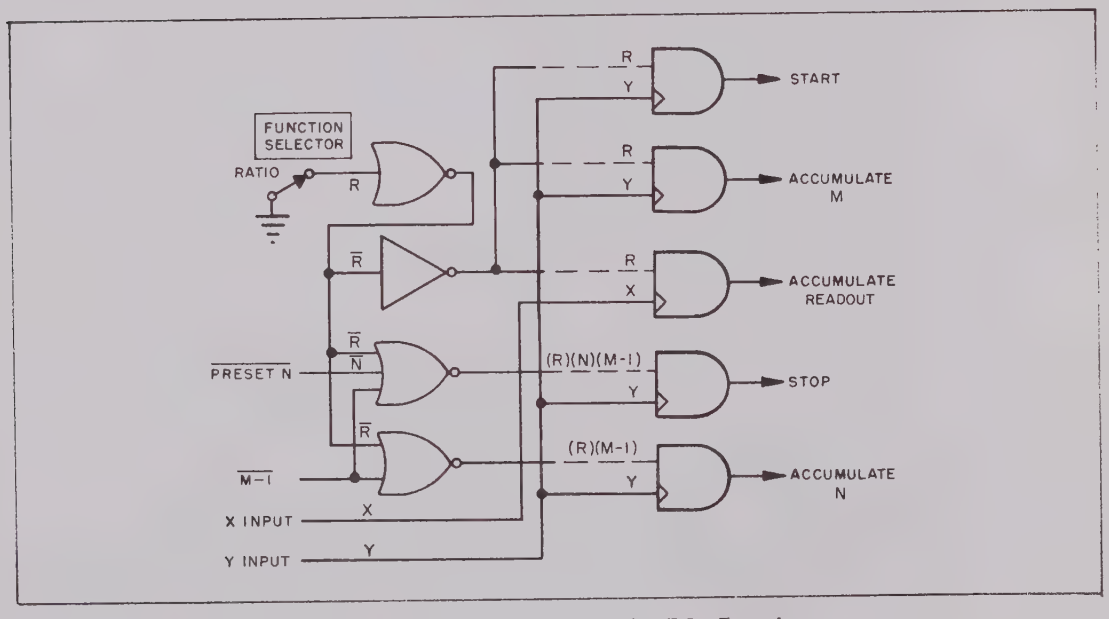


Fig. 3-7. Basic RATIO Logic

3.9.4 COUNT Function

Figure 3-8 shows the basic logic diagram for the Count Function Board. With the FUNCTION selector in the COUNT position, the start and accumulate M gates are controlled open. The accumulate readout and auxiliary reset gates are controlled open when the N and M DCU's have accumulated preset N and M-1 events, respectively. The accumulate N gate is controlled open when the M DCU's have accumulated M-1 events. Outputs to the Gate Control Board are then triggered by clock or X input pulses occurring at the next instant of time.

DC levels to the Timing Control Board are used to cause the readout display to continually follow the readout DCU's. These levels appear on control lines #1 and #2 from the Timing Control Board (pins M_R and N_R, respectively).

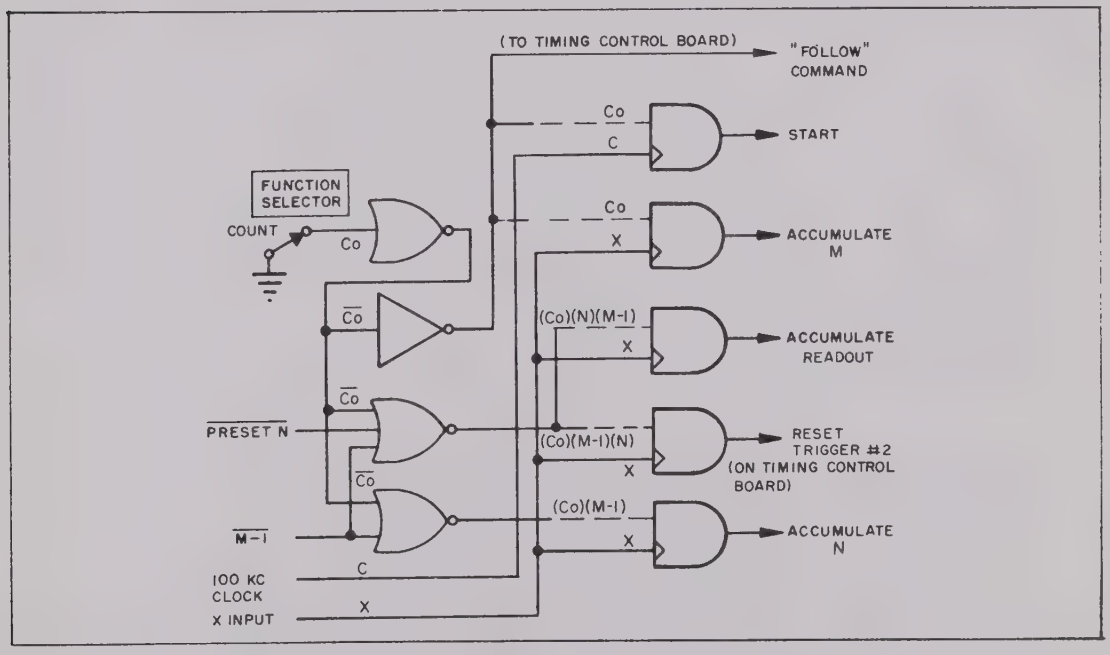


Fig. 3-8. Basic COUNT Logic

3.10 GATE CONTROL BOARD

3.10.1 Operation

The Gate Control Board controls transmission of data to the three DCU banks and the "control inhibit" signal to the Timing Control Board. Inputs to the Gate Control Board come from the four function boards.

The "control inhibit" signal to the timing control determines the time interval between stop counting and reset of DCU's. The actual DCU reset pulse is generated in the Timing Control Board.

The count gate remains closed until a "start" command is received from the function boards. Hereafter until a "stop" command is received, all data from the function board is transmitted to the three DCU banks. Figure 3-9 shows a timing diagram for the Gate Control Board.

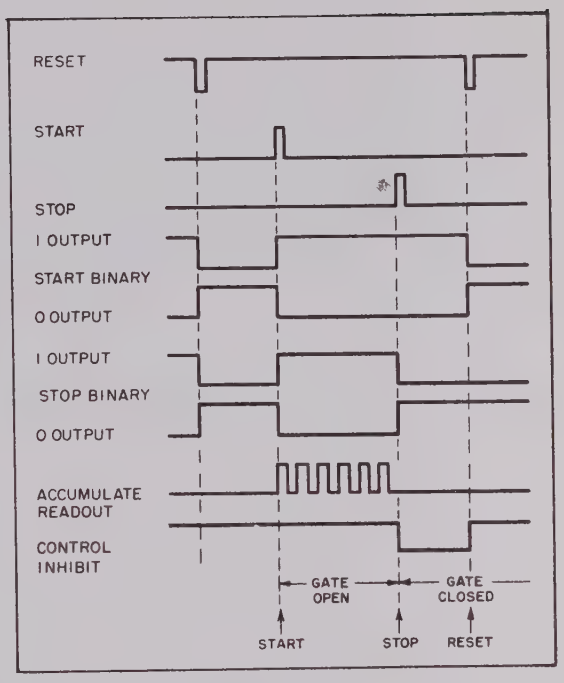


Fig. 3-9. Gate Control Board Timing Diagram

3.10.2 Description

A logic diagram for the Gate Control board is shown in Figure 3-10. The board essentially consists of two binaries (flip-flops) and three monostable multivibrators. Each of the latter generates 150 nanosecond pulses to one of the DCU banks.

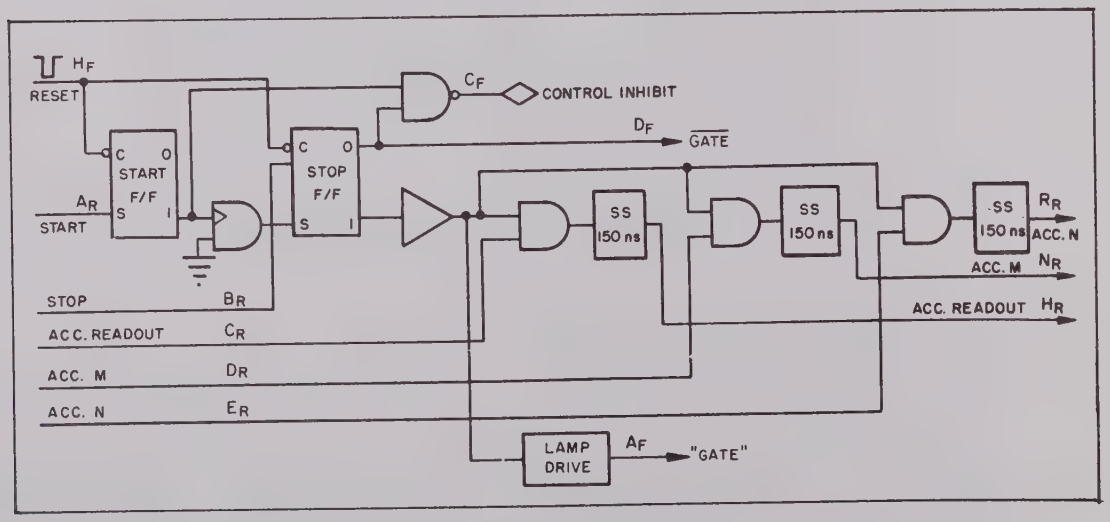


Fig. 3-10. Gate Control Board Logic Diagram

3.11 TIMING CONTROL BOARD

3.11.1 Operation

The Timing Control Board controls the count, data transfer and display time intervals for the instrument. The various control and triggering signals which initiate these intervals are generated within the Timing Control Board. Two timing circuits on the board are used to determine the set and display time intervals. Board logic is shown in Figure 3-11. The timing diagram shown in Figure 3-12 is helpful in understanding the sequence of events occurring within the board.

3.11.2 Description

The Timing Control Board uses conventional logic circuitry. The two timing circuits in the board are regenerative astable multivibrators which are designed to provide output pulses having minimum rise and fall times. At the proper instant, these circuits are unclamped from their inactive states to provide a predetermined time interval. In returning to their original states, the resulting transients are used to initiate the next sequence of events. (Refer to Figure 3-12.)

1) A "stop" pulse triggers the "control inhibit" signal to the Timing Control Board.
2) The "control inhibit" signal is delayed 100 nanoseconds and inverted.
3) The resulting signal is used to unclamp the data set timer from its inactive state. During the set interval, the display follows the readout DCU's.
4) The first positive transient from the set timer is used to clear the timing flip-flop.
5) The zero output from the flip-flop returns to ground potential, unclamping the display timer from its inactive state.
6) The display timer generates an output.
7) The zero output from the timing flip-flop is also used to reclamp the data set timer to its inactive state.
8) After the preset display interval, the display timer returns to ground potential.
9) The positive transient from the display timer is used to trigger generator #1. The generated pulse resets the gate control inhibit line. Reset generator #1 also resets the readout DCU's and the NM DCU's by triggering reset generator #2.
10) A signal from reset generator #1 is used to set the timing flip-flop.

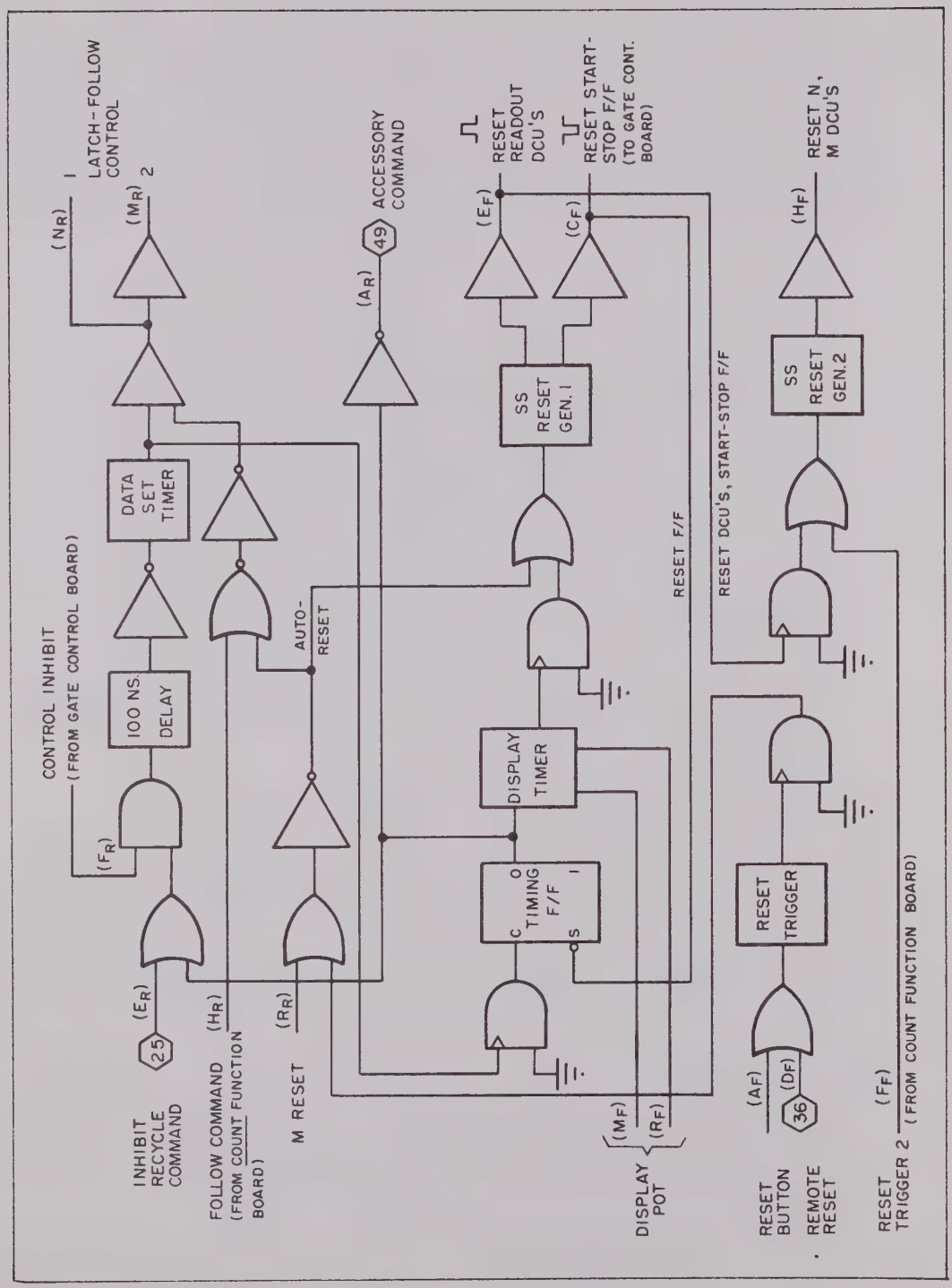


Fig. 3-11. Timing Control Board Logic Diagram

11) The presence of an "inhibit recycle" signal from accessory recording instruments delays the "data set" pulse (data transfer time) for as long a period as required to record the preceding sampled data.

3.12 DECIMAL COUNTING UNITS

The decimal counting units used in this instrument can count in the forward direction from zero to nine and generate an output "carry" pulse to the next DCU.

The basic DCU generates one output pulse for every ten input pulses. This division process is accomplished by first dividing by two and then by five. Thus, the basic counting unit is a "bi-quinary" divider. The bi-quinary decimal code is given in Table 3-1, and is represented in the circuitry by the states of seven transistors.

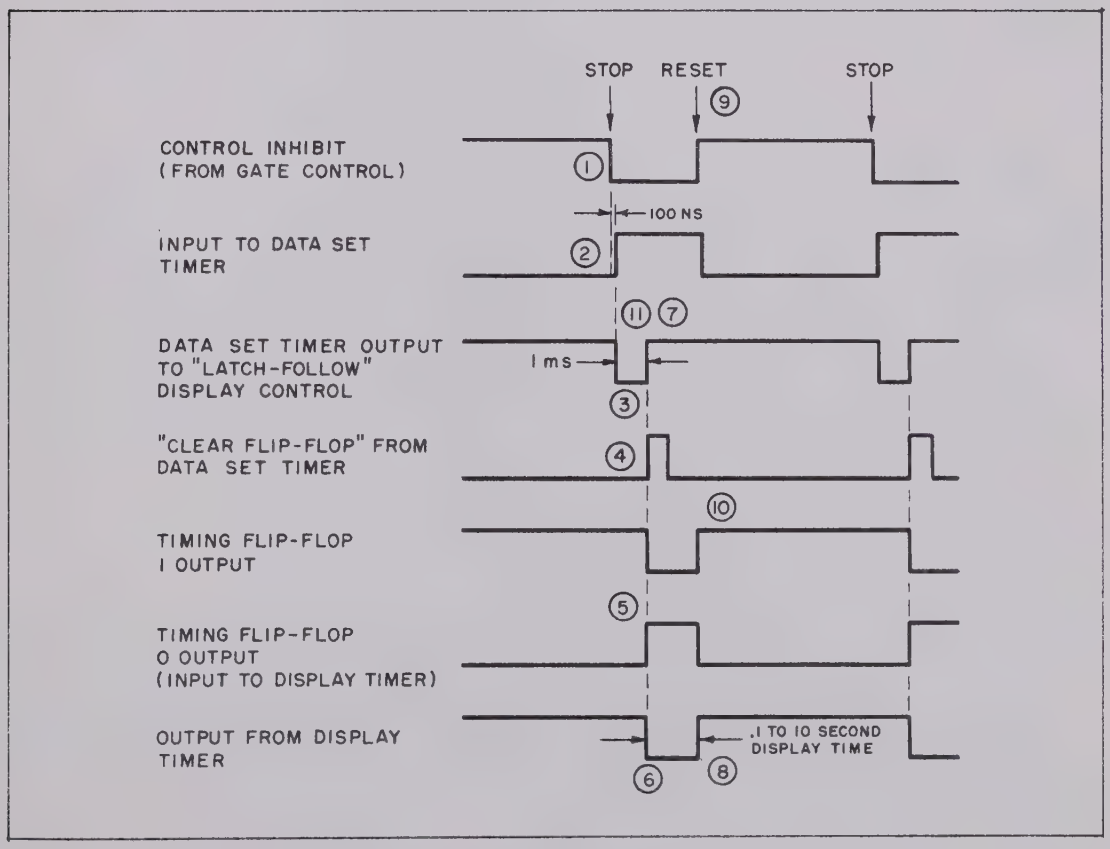


Fig. 3-12. Timing Control Board Timing Signals

Table 3-1. Bi-Quinary Decimal Code

Decimal	Binary		Quinary				
	Q1	Q2	Q7	Q8	Q9	Q10	Q11
0	1	0	1	0	0	0	0
1	0	1	1	0	0	0	0
2	1	0	0	1	0	0	0
3	0	1	0	1	0	0	0
4	1	0	0	0	1	0	0
5	0	1	0	0	1	0	0
6	1	0	0	0	0	1	0
7	0	1	0	0	0	1	0
8	1	0	0	0	0	0	1
9	0	1	0	0	0	0	1

The binary portion of the DCU is a flip-flop which reverses states whenever a forward count is received. The quinary portion of the DCU contains five transistors which can be in either the logic "1" (transistor OFF) or logic "0" (transistor ON) states. Quinary circuitry is designed such that the single OFF transistor shifts one stage to the right each time a forward count is received from the binary count gate. The DCU is designed to generate a "carry" signal to the next DCU stage upon receiving a forward count while a decimal "9" is being represented. Figure 3-13 shows the basic logic diagram for the DCU and obeys the code given in Table 3-1.

3.12.1 Multiple Time Base Logic

The "multiple" counting unit consists of a bank of three DCU's. When a multiple is chosen on the front panel, the DCU chain is terminated at a particular DCU by keeping the forward count gate from the binary portion of the DCU closed. The MULTIPLE selector switch grounds the output of one of the binary transistors through the time base logic board, thus terminating the chain of DCU's at one of the three multiples.

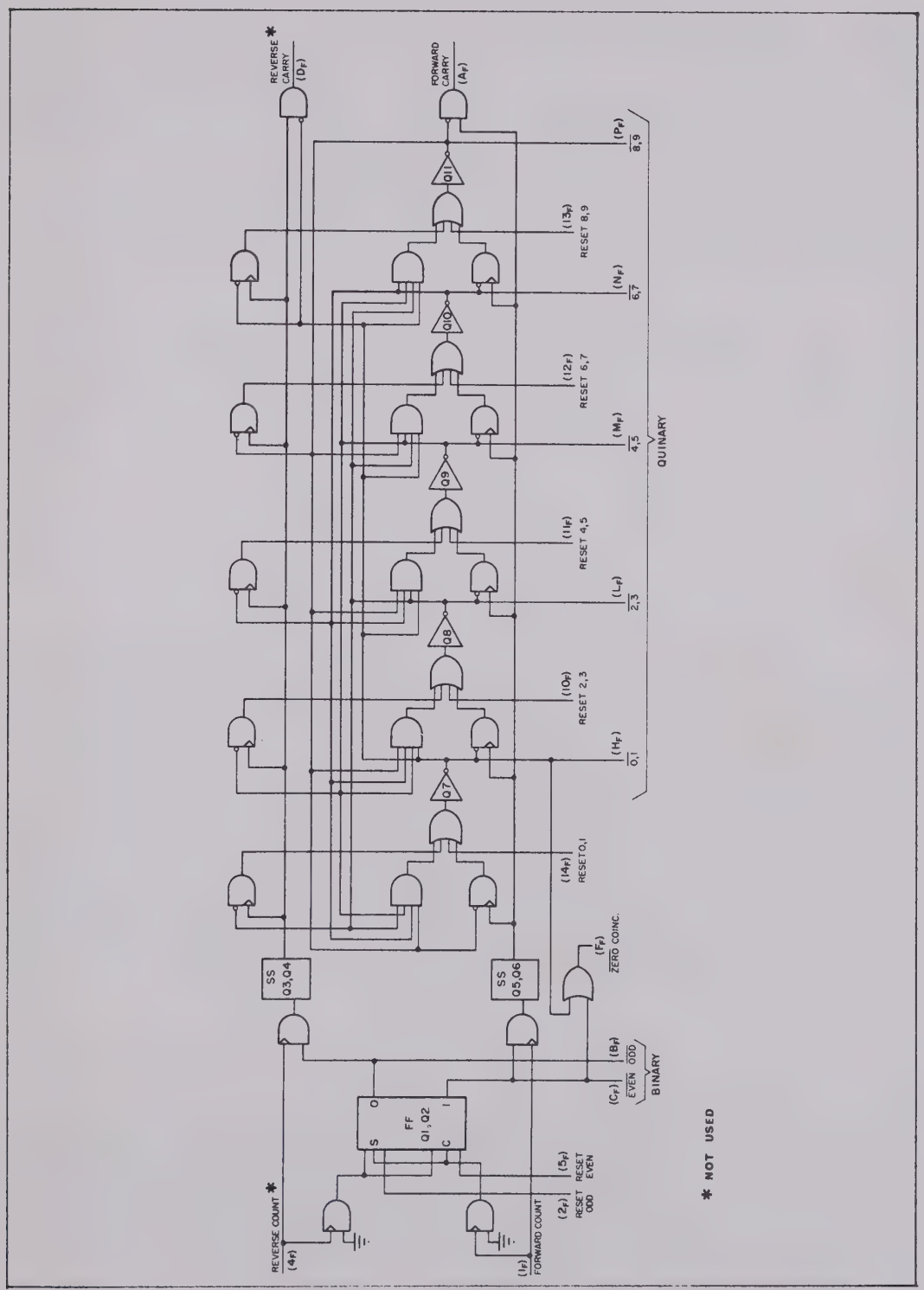


Fig. 3-13. Forward Decimal Counting Unit Logic Diagram

3.12.2 Latch-Follow Control

Storage circuitry is used with the readout DCU's. Data present in the readout DCU's is transferred to storage during the "data set" interval. Following the transfer period, the data is stored and displayed ("latched") until the next data transfer period.

Latch or follow control is accomplished with specific combinations of voltage on control lines 1 and 2. These voltage levels are listed in Table 3-2.

Table 3-2. Latch-Follow Control Voltages

	Control Line 1	Control Line 2
Follow	+0.6	+5
Latch	-14	+0.7

These voltages are generated in the Timing Control Board by the data set timer and appear at Pins M_R and N_R, respectively.

The basic storage circuit is shown in Figure 3-14. Assume that the control lines are in "follow", and that one quinary transistor is ON and the other OFF, resulting in Q2 OFF and Q4 ON during the follow period. Then both Q1 and Q3 are biased OFF. When the control lines switch to "latch", Q1 is turned ON but Q3 remains OFF. During "latch", control line 1 drops sufficiently negative to draw current through R2 and R6. Current through R2 is drawn from Q1 while current through R6 is drawn from the base of Q4. Thus, changing from "follow" to "latch" results in maintaining Q2 OFF and Q4 ON regardless of variations at inputs 1 and 2 throughout the latch period. In this way, data can be stored until the next follow period, at which time the control voltages assume values for "follow" and data contained in the quinary transistors can again be transferred to storage.

3.13 PRESET N SWITCH

The Preset selector switch is designed to generate a unique output whenever its associated DCU reaches the preset decimal digit. Outputs from the five switches are connected to an AND gate, the output of which goes to the Preset Output Board. Figure 3-15 is a schematic showing switch operation.

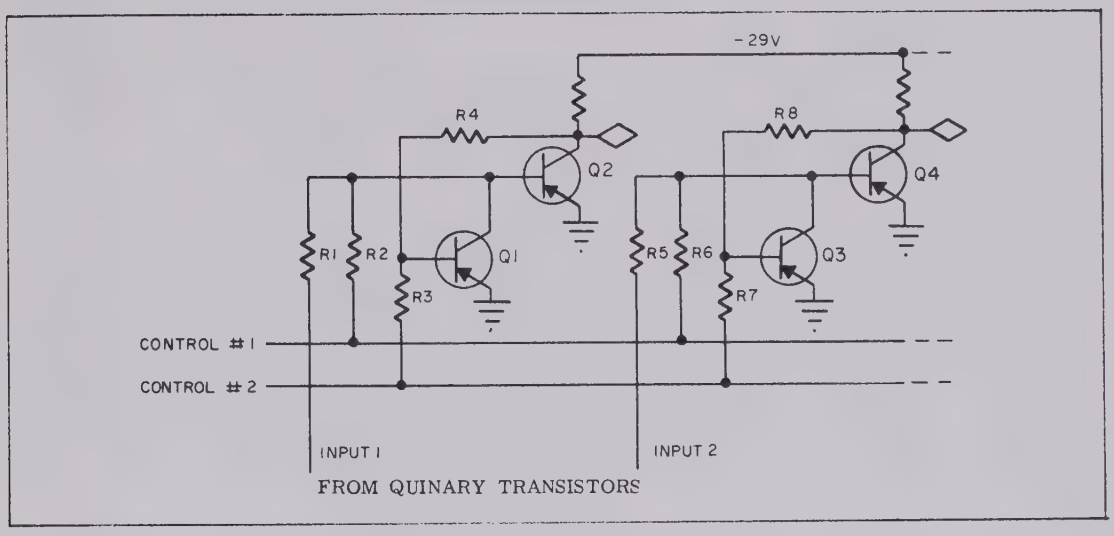


Fig. 3-14. Latch-Follow Storage Circuit

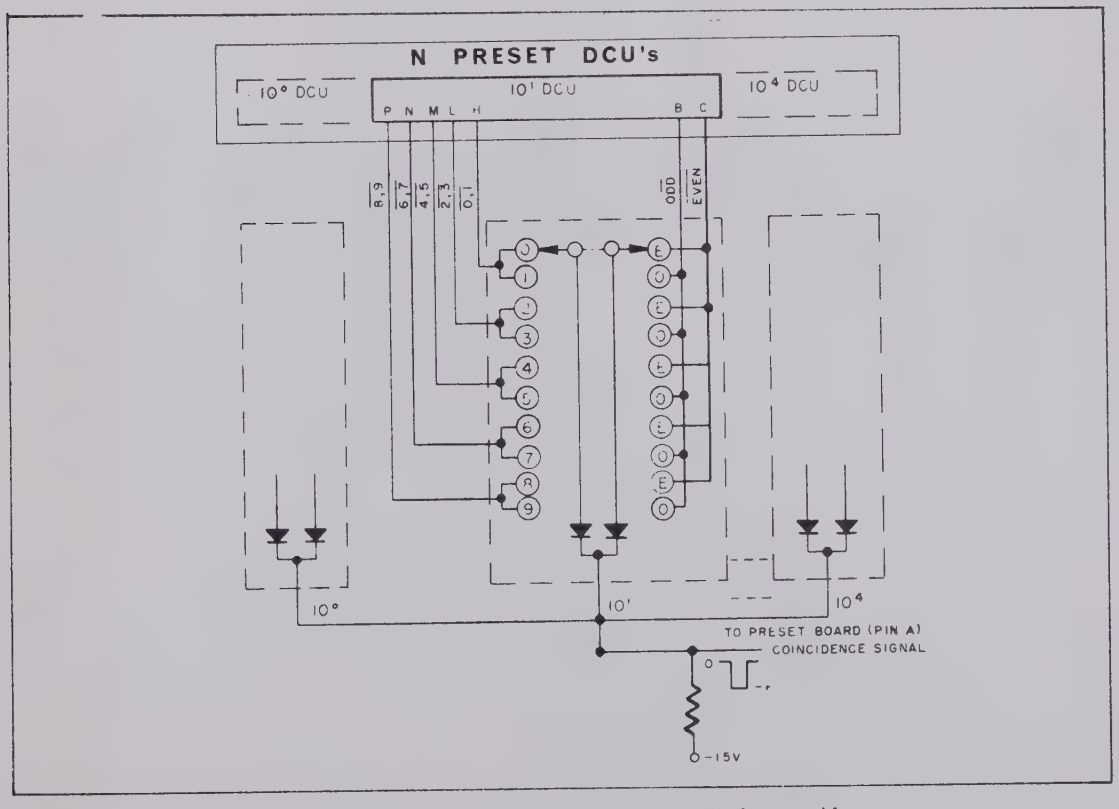


Fig. 3-15. Preset Switch Schematic

3.14 N-1 LOGIC

The Model 6020 uses N-1 logic, meaning that the particular gates in the function boards are opened on the (N-1)th input pulse, thus insuring instantaneous stop, N accumulate, or reset on the Nth input or following clock pulse.

This is accomplished in the Model 6020 by resetting the N and M DCU banks to "1" instead of "0". For example, if M is 100 and the instrument is operating in RATIO, the M DCU's generate an "M-1" control signal to the RATIO function board on the 99th pulse that is receives. An "accumulate N" signal can then be generated on the next Y input. When the N DCU's reach preset N, a "preset N" signal level is generated to the function board. The stop gate can then be controlled open with the next "N-1" signal. The count gate immediately closes on the next Y input.

A timing diagram illustrating N-1 logic is shown in Figure 3-16. In the illustration, N is chosen to be 2, M to be 10, and the FUNCTION to be RATIO.

3.15 READOUT DISPLAY

The dual decimal outputs and odd-even lines from the readout DCU's are used to select the correct decimal digit in the lamp blocks. A diagram of DCU to lamp block connection is shown in Figure 3-17. For specific information on dual decimal output circuitry from the DCU's, refer to the DCU schematic.

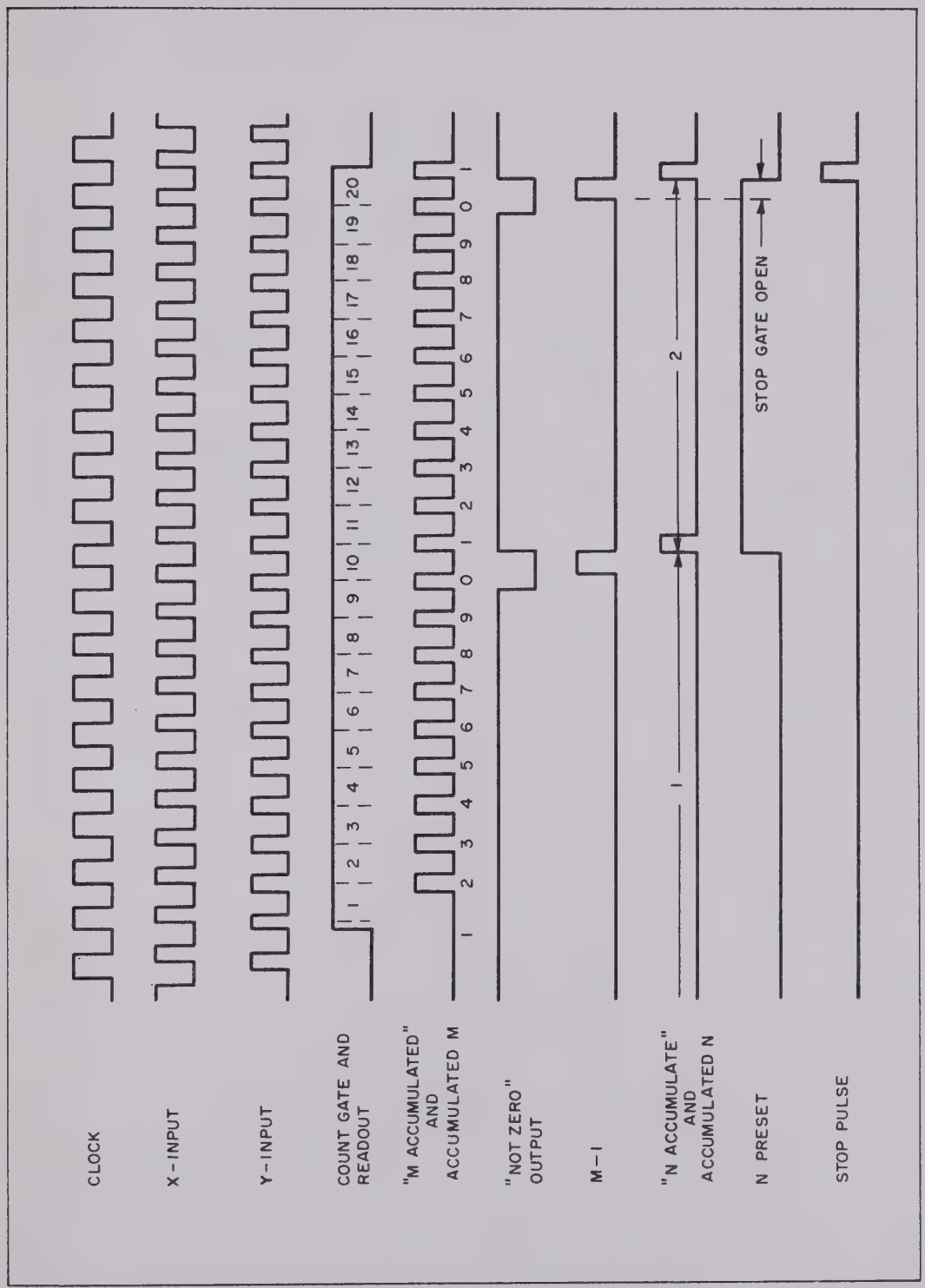

CLOCK
X-INPUT
Y-INPUT
COUNT GATE AND READOUT
"M ACCUMULATED" AND ACCUMULATED M
"NOT ZERO" OUTPUT
M-1
"N ACCUMULATE" AND ACCUMULATED N
N PRESET
STOP PULSE
STOP GATE OPEN
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1
2

Fig. 3-16. N-1 Logic Timing Diagram

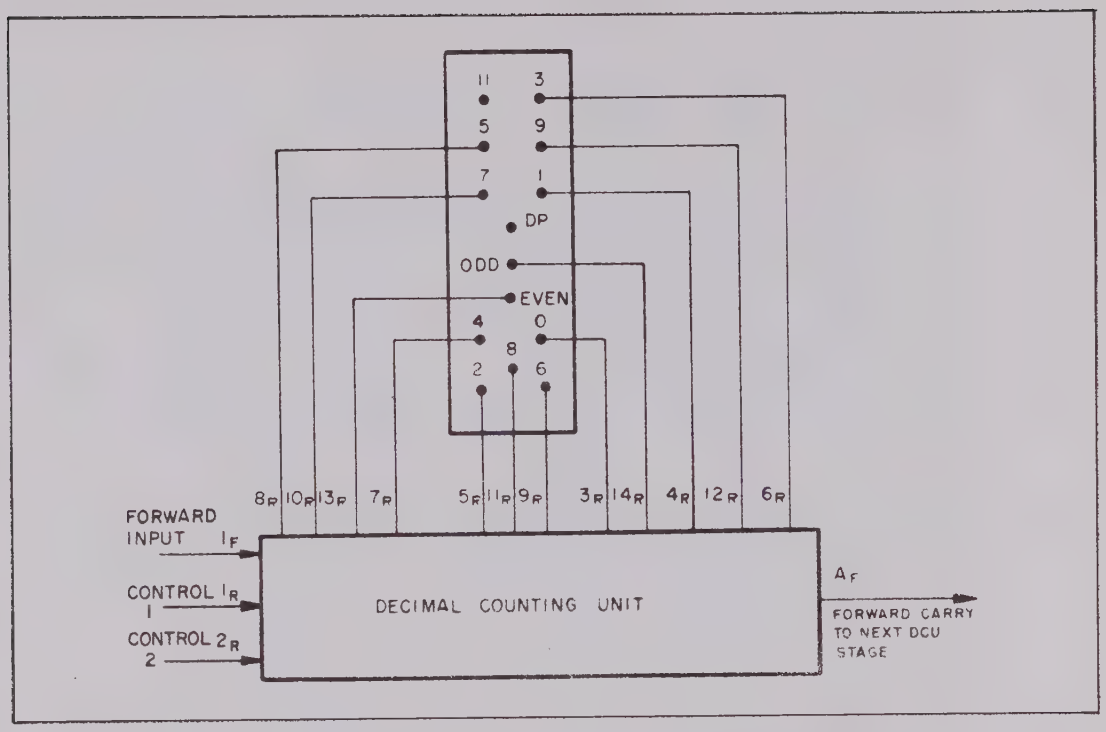


Fig. 3-17. Lamp Block - DCU Interconnection

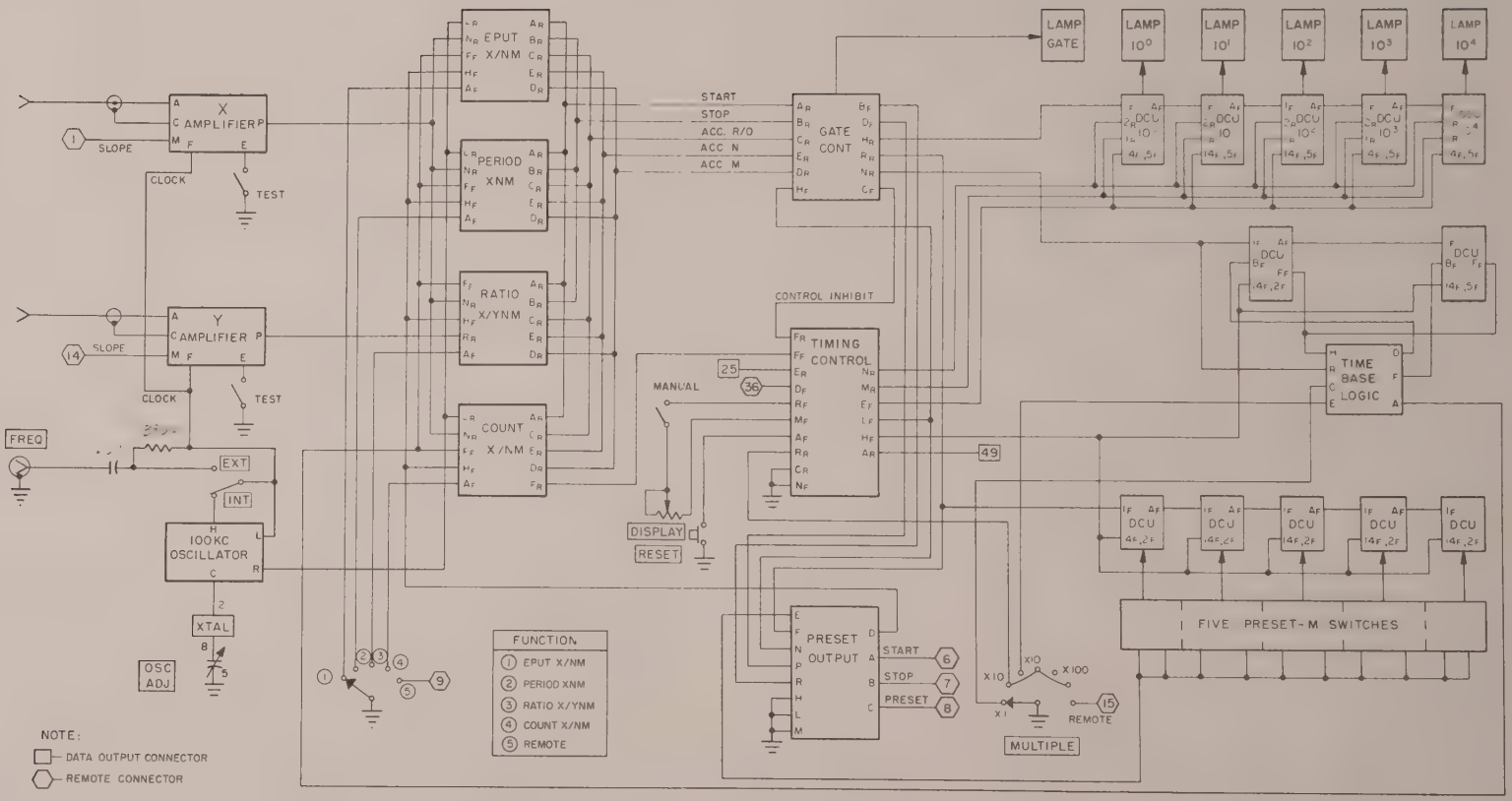


Fig. 3-1. Model 6020 Block Diagram

SECTION 4

SERVICING

4.1 GENERAL

This section provides adjustment procedures and general troubleshooting information for the instrument.

4.1.1 Recommended Test Equipment

Table 4-1 lists the specifications for test instruments used in servicing the instrument. Other instruments may be used if their specifications meet or exceed the listed specifications.

Table 4-1. Recommended Test Equipment

Instrument	Specifications
Oscilloscope	50 mc bandwidth; 3.5 nanosecond rise time.
Signal Generator	1 cps to 100 kc; 1 volt rms output. 100 kd to 2 mc; 1 volt rms output.
Volt-ohmmeter	100 k ohms 1 volt dc.
Auto Transformer	0-130 volts ac, 60 cps.

4.1.2 Board Layout

Use the drawing on the inside top cover of the instrument to locate boards on the main chassis. Components on particular printed circuit boards are located using the board layout drawings included in the rear of the manual.

4.1.3 Extender Boards

Two extender boards have been furnished with the instrument to provide easy access to components and test points on printed circuit boards during operation.

4.2 ADJUSTMENTS

4.2.1 Power Supply Adjustments

The regulated power supply adjustments are located on the regulator board (Figure 4-2).

Power supply test points are located on the underside of the chassis along a horizontal terminal strip. Use Figure 4-2 to locate power supply test points. Wires from these test points are color coded as follows: RED +15 V., GREEN -15 V., YELLOW -29 V.,

4.2.1.1 Adjustment Procedure

CAUTION

Do not remove the regulator board from its receptable without first unplugging the ac line cord from its power source.

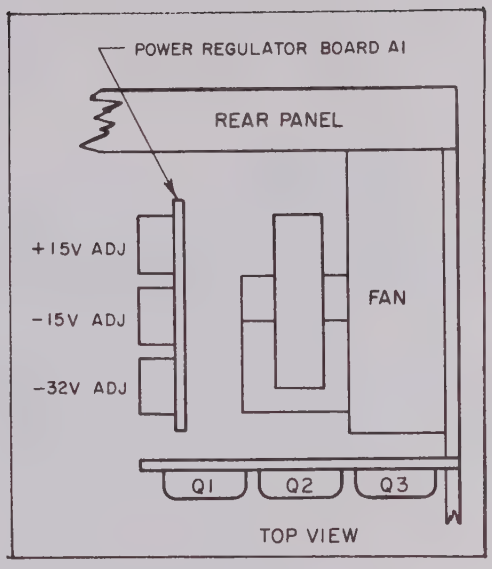


Fig. 4-1. Location of Power Supply Adjustment

1) Use a voltmeter of at least 1% accuracy. Voltage measurements are referenced to chassis ground.

2) Use Figure 4-2 to locate power supply test points.

3) Adjust +15 V terminal to +15 volts, ±0.2 volt.

4) Adjust -15 V terminal to -15 volts, ±0.2 volt.

5) Adjust -29 V terminal to approximately -29 volts.

4.2.2 Triggering Level Adjustment

Triggering level adjustment and test points are on the amplifier board and are accessible from the top of the instrument. There are two test points marked on the board: LEVEL and TEST. Voltage appearing at LEVEL is the actual triggering level, or value which the input voltage must exceed in order to trigger the input circuit. Voltage appearing at TEST is the actual amplifier output.

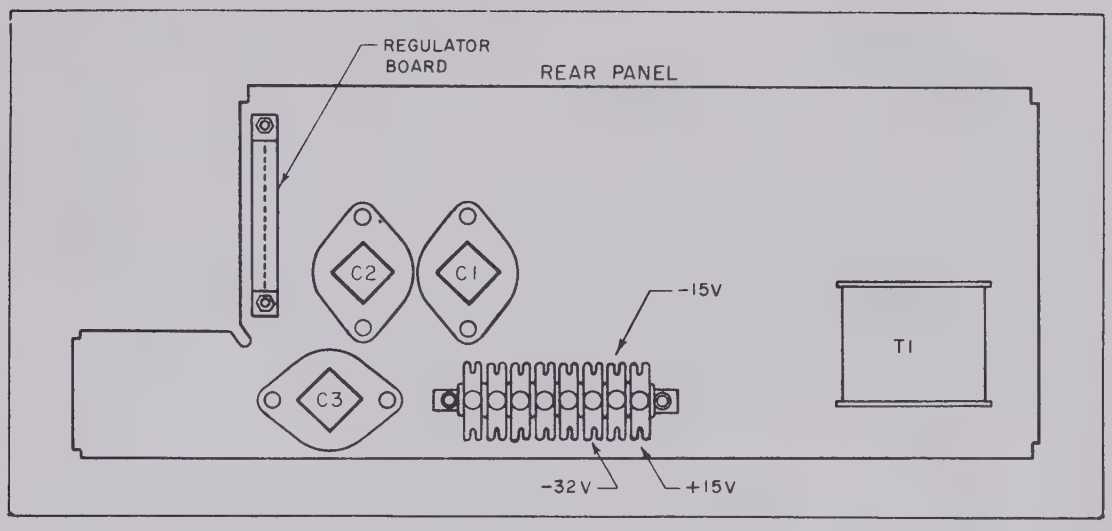


Fig. 4-2. Location of Power Supply Test Points

4.2.2.1 Adjustment Procedure

1) Connect voltmeter of at least 1% accuracy to LEVEL and oscilloscope to TEST.

2) Connect signal generator amplifier input. Using a 100 kc signal, set the rms voltage to the desired level.

3) Using the potentiometer mounted on the amplifier board, adjust the discriminator for desired sensitivity. Maximum sensitivity is indicated by the appearance of an output pulse train with approximately 50% duty cycle.

4) Actual triggering level (plus hysteresis) is indicated by the dc voltmeter. A reading of approximately 0 volts indicates maximum sensitivity.

4.2.3 Oscillator Adjustment

Adjustment of the oscillator frequency is seldom necessary. Oscillator adjustment and test points are located on the rear panel as shown in Figure 4-3.

4.2.3.1 Procedure

When adjustments are necessary, use the following procedure:

1) Use Figure 4-3 to locate oscillabor adjustment (FREQ. ADJ.) and test point (J5).

2) Connect an oscilloscope or frequency counter to J5. If an oscilloscope is used, its input impedance must not affect oscillator frequency.

3) With the EXT-INT switch in the INT position, use the FREQ. ADJ. to adjust oscillator frequency to 100 kc.

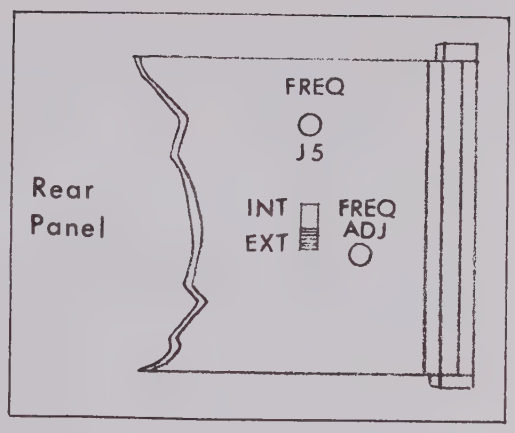


Fig. 4-3. Rear Panel Oscillator Adjustment and Connector

4.3 TROUBLESHOOTING

4.3.1 General

Most circuits in the instrument are mounted on printed circuit boards which can be removed and replaced easily. Troubleshooting may be greatly simplified by replacing boards suspected of being faulty with spare boards which are known to be in good working order. Once the faulty board is identified, it can be repaired and returned to operation.

4.3.2 Replacing Components on Printed Circuit Boards

To prevent damage to the printed circuit board and its components, use heat sparingly and work carefully. Follow this procedure for removing a defective component.

1) Melt solder in the component lead holes and tap board gently to remove solder around component leads.

2) Straighten component leads with long-nose pliers or soldering aid.

3) Remove defective component.

4) If component cannot be removed, reheat leads slightly.

To install a new component follow this procedure.

1) Clean lead holes thoroughly.

2) Cut and bend component leads to proper length and shape.

3) Insert leads into holes and solder into place.

NOTE

When installing transistor or diode, use a heat sink to prevent excessive heat conduction through the component. Long-nose pliers applied between the component and soldering iron make an effective heat sink.

4.3.3 General Troubleshooting

Troubles can often be isolated to an individual circuit board by observing front panel indications in the various operating modes. The wiring diagram included in the rear of the manual will also be useful.

When the faulty board has been located, some of the idealized waveforms and voltage levels given in Section 3 may be helpful in locating the problem. General troubleshooting is facilitated by combined use of logic diagrams given in Section 3 and individual board schematics included in the back of the manual.

SECTION 5

PARTS LIST

NOTE: The following assemblies are present in the standard Model 6020.

Beckman Stock No.	Assembly	Page
887-426372	Input Amplifier Printed Circuit Board	5-1
887-425479	EPUT Function Printed Circuit Board	5-3
887-425480	COUNT Function Printed Circuit Board	5-5
887-425481	PERIOD Function Printed Circuit Board	5-6
887-425482	RATIO Function Printed Circuit Board	5-7
887-424721	Time Base Logic Printed Circuit Board	5-9
887-426251	Timing Control Printed Circuit Board	5-10
887-425446	Gate Control Printed Circuit Board	5-11
887-426432	Preset Output Printed Circuit Board	5-13
887-426103	DCU with Readout P.C. Board	5-14
887-426107	DCU without Readout P.C. Board	5-16
887-424010	100Kc/1Mc Oscillator P.C. Board	5-17
	Oscillator Assembly	5-18
	Power Supply	5-19
	Miscellaneous	5-19

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
	887-426372	INPUT AMPLIFIER P.C. BOARD	
C1	633-804715	Capacitor, F. Cerm., 0.01μf, 50V	5
C2	633-838427	Capacitor, F. Cerm., 15pf, 500V	1
C3	633-838425	Capacitor, F. Cerm., 22pf, 500V	1
C4 thru C7		Same as C1	
CR1	755-420893	Diode, 893	8
CR2		Same as CR1	
CR3	775-815561	Diode, 1N3064 (CD6111)	5
CR4 & CR5		Same as CR3	
CR6 thru CR9		Same as CR1	
CR10 & CR11		Same as CR3	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
CR12 & CR13		Same as CR1	
Q1	755-425735	Transistor, Special	5
Q2		Same as Q1	
Q3	755-838784	Transistor, 2N3565	2
Q4		Same as Q3	
Q5	755-838105	Transistor, 2N3638	3
Q6		Same as Q5	
Q7 thru Q9		Same as Q1	
Q10		Same as Q5	
R1	601-823387	Resistor, R. Comp., 47Ω, 1/4W, 5%	3
R2	601-822301	Resistor, F. Comp., 15K, 1/4W, 5%	4
R3	601-822326	Resistor, F. Comp., 1.2K, 1/4W, 5%	3
R4		Same as R2	
R5	601-823386	Resistor, F. Comp., 39Ω, 1/4W, 5%	2
R6		Same as R5	
R7	601-822331	Resistor, F. Comp., 8.2K, 1/4W, 5%	2
R8	601-823391	Resistor, F. Comp., 150Ω, 1/4W, 5%	2
R9		Same as R34	
R10		Same as R7	
R11		Same as R2	
R12	611-826874	Resistor, Var., 10K, W.W.	1
R13	601-823902	Resistor, F. Comp., 47K, 1/4W, 5%	1
R14 & R15	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	4
R16	601-823908	Resistor, 220K, 1/4W, 5%	1
R17		Same as R14	
R18		Same as R2	
R19	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	1
R20		Same as R1	
R21 & R22	601-822296	Resistor, F. Comp., 3.3K, 1/4W, 5%	2

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
R23	601-823904	RESISTOR, F. Comp. 100K, 1/4W, 5%	1
R24	601-823397	RESISTOR, F. Comp. 5.6K, 1/4W, 5%	1
R25		Same as R14	
R26	601-822335	RESISTOR, F. Comp. 27K, 1/4W, 5%	2
R27	601-822303	RESISTOR, F. Comp. 18K, 1/4W, 5%	1
R28		Same as R8	
R29 & R30		Same as R3	
R31	601-822544	RESISTOR, F.Comp. 1.8K, 1/4W, 5%	2
R32		Same as R31	
R33	601-822369	RESISTOR , F. Comp. 680Ω, 1/4W, 5%	1
R34	601-079172	RESISTOR, F. Comp., 820Ω, 1/ 2W, 5%	2
R35	601-822297	RESISTOR, F. Comp., 4.7K, 1/4W, 5%	3
R36 & R37		Same as R35	
R38		Same as R1	
R39		Same as R26	

	887-425479	EPUT FUNCTION P.C. BOARD	
C1	637-822976	CAPACITOR, 33pf , 300V, 5%	5
C2 & C3		Same as C1	
C5 & C6		Same as C1	
C7	633-804715	CAPACITOR, .01uf, 50V	1
C8 & C9	633-804717	CAPACITOR, .01uf, 500V	2
CR1	755-420893	DIODE, SPECIAL	11
CR7 thru CR9		Same as CR1	
CR11	755-815561	DIODE, CD6111	7
CR22		Same as CR1	
CR24		Same as CR1	
CR26		Same as CR11	
CR33		Same as CR1	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
CR34		Same as CR11	
CR35		Same as CR1	
CR37		Same as CR11	
CR39		Same as CR1	
CR40		Same as CR11	
CR44		Same as CR1	
CR46		Same as CR11	
CR48		Same as CR1	
CR49		Same as CR11	
Q2	755-425735	TRANSISTOR, SPECIAL	2
Q5		Same as Q2	
Q7	755-838105	TRANSISTOR, 2N3638	2
Q8		Same as Q7	
R1	601-822297	RESISTOR, F. Comp. 4.7K, 1/4W, 5%	10
R2		Same as R1	
R3	601-822334	RESISTOR, F. Comp. 22K, 1/4W, 5%	2
R4 & R5		Same as R1	
R6		Same as R3	
R7 & R8		Same as R1	
R13	601-822299	RESISTOR, F. Comp. 6.8K, 1/4W, 5%	2
R14	601-822324	RESISTOR, F. Comp. 10K, 1/4W, 5%	7
R15 & R16		Same as R1	
R25		Same as R13	
R26		Same as R14	
R27		Same as R1	
R28		Same as R1	
R33 thru R35		Same as R14	
R37 & R38		Same as R14	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
	887-425480	COUNT FUNCTION P.C. BOARD	
C1	637-822976	CAPACITOR, 33pf, 300V, 5%	5
C3 thru C6		Same as C1	
C7	633-804715	CAPACITOR, .01μf 50V	1
C8 & C9	633-804717	CAPACITOR, .01μf 500V	2
CR1	755-420893	DIODE, Special	11
CR12 thru CR14		Same as CR1	
CR16	755-815561	DIODE, CD6111	7
CR22		Same as CR1	
CR24		Same as CR1	
CR26		Same as CR16	
CR33		Same as CR1	
CR34		Same as CR16	
CR38		Same as CR1	
CR40		Same as CR16	
CR41		Same as CR1	
CR43		Same as CR16	
CR44		Same as CR1	
CR46		Same as CR16	
CR48		Same as CR1	
CR49		Same as CR16	
Q3	755-425735	TRANSISTOR, SPECIAL	2
Q5		Same as Q3	
Q7	755-838105	TRANSISTOR, 2N3638	2
Q8		Same as Q7	
R1	601-822297	RESISTOR, F. Comp. 4.7K, 1/4W, 5%	10
R2		Same as R1	
R3	601-822334	RESISTOR, F. Comp. 22K, 1/4W, 5%	2
R4 & R5		Same as R1	
R6		Same as R3	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
R7 & R8		Same as R1	
R17	601-822299	RESISTOR, F. Comp. 6.8K, 1/4W, 5%	2
R18	601-822324	RESISTOR, F. Comp. 10K, 1/4W, 5%	7
R19 & R20		Same as R1	
R25		Same as R17	
R26		Same as R18	
R27 & R28		Same as R1	
R33		Same as R18	
R35 thru R38		Same as R18	
	887-425481	PERIOD FUNCTION P.C. BOARD	
C1	637-822976	CAPACITOR, 33pf 300V, 5%	5
C2 & C3		Same as C1	
C5 & C6		Same as C1	
C7	633-804715	CAPACITOR, .01μf, 50V	1
C8	633-804717	CAPACITOR, .01 μf, 500V	2
C9		Same as C8	
CR1	755-420893	DIODE, SPECIAL	11
CR7 thru CR9		Same as CR1	
CR11	755-815561	DIODE, CD6111	7
CR22 & CR24		Same as CR1	
CR26		Same as CR11	
CR33		Same as CR1	
CR34		Same as CR11	
CR35		Same as CR1	
CR37		Same as CR11	
CR39		Same as CR1	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
CR40		Same as CR11	
CR44		Same as CR1	
CR46		Same as CR11	
CR48		Same as CR1	
CR49		Same as CR11	
Q2	755-425735	TRANSISTOR, SPECIAL	2
Q5		Same as Q2	
Q7	755-838105	TRANSISTOR, 2N3638	2
Q8		Same as Q7	
R1	601-822297	RESISTOR, F. Comp. 4.7K, 1/4W, 5%	10
R2		Same as R1	
R3	601-822334	RESISTOR, F. Comp. 22K, 1/4W, 5%	2
R4 & R5		Same as R1	
R6		Same as R3	
R7 & R8		Same as R1	
R13	601-822299	RESISTOR, F. Comp. 6.8K, 1/4W, 5%	2
R14	601-822324	RESISTOR, F. Comp. 10K, 1/4W, 5%	7
R15 & R16		Same as R1	
R25		Same as R13	
R26		Same as R14	
R27 & R28		Same as R1	
R33 thru R35		Same as R14	
R37 & R38		Same as R14	

	887-425482	RATIO FUNCTION P.C. BOARD	
C1	637-822976	CAPACITOR, 33pf, 300V, 5%	5
C2 & C3		Same as C1	
C5 & C6		Same as C1	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
C7	633-804715	CAPACITOR, .01μf , 50V	1
C8	633-804717	CAPACITOR, .01 μf, 500V	2
C9		Same as C8	
CR1	755-420893	DIODE, SPECIAL	11
CR7 thru CR9		Same as CR1	
CR11	755-815561	DIODE, CD6111	7
CR22		Same as CR1	
CR24		Same as CR1	
CR26		Same as CR11	
CR33		Same as CR1	
CR34		Same as CR11	
CR35		Same as CR1	
CR37		Same as CR11	
CR39		Same as CR1	
CR40		Same as CR11	
CR44		Same as CR1	
CR46		Same as CR11	
CR48		Same as CR1	
CR49		Same as CR11	
Q2	755-425735	TRANSISTOR, SPECIAL	2
Q5		Same as Q2	
Q7	755-838105	TRANSISTOR, 2N3638	2
Q8		Same as Q7	
R1	601-822297	RESISTOR, F. Comp. 4.7K, 1/4W, 5%	10
R2		Same as R1	
R3	601-822334	RESISTOR, F. Comp. 22K, 1/4W, 5%	2
R4 & R5		Same as R1	
R6		Same as R3	
R7 & R8		Same as R1	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
R13	601-822299	RESISTOR, F. Comp. 6.8K, 1/4W, 5%	2
R14	601-822324	RESISTOR, F. Comp. 10K, 1/4W, 5%	7
R15 & R16		Same as R1	
R25		Same as R13	
R26		Same as R14	
R27 & R28		Same as R1	
R33 thru R35		Same as R14	
R37 & R38		Same as R14	

	887-424721	TIME BASE LOGIC P.C. BOARD	
C1	633-804715	Cap. 0.01 μf 50V	5
C3 thru C6		Same as C1	
CR1	755-420893	DIODE, SPECIAL	5
CR2	755-815561	DIODE, CD6111	2
CR3		Same as CR2	
CR4 thru CR7		Same as CR1	
Q1	755-419596	TRANSISTOR, Special	1
R1	601-823397	RESISTOR, 5.6K, 1/4W, 5%	1
R2	601-822328	RESISTOR, 2.2K, 1/4W, 5%	1
R3		Not used	
R4	601-822301	RESISTOR, 15K, 1/4W, 5%	5
R5 thru R8		Same as R4	
R9	601-822308	RESISTOR, 1K, 1/4W, 5%	1
R10		Not used	
R11	601-817735	RESISTOR, 100Ω, 1/4W, 5%	4
R12 thru R14		Same as R11	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
	887-426251	TIMING CONTROL P.C. BOARD	
C1	633-804706	Cap. F. Cerm, .001 μf, 1KV	1
C2	633-804713	Cap. F. Cerm, 0.005μf, 50V	1
C3	637-827575	Cap. F. Mica, 18pf, 500V	2
C4	633-838426	Cap. F. Cerm, 33pf, 500V	5
C5	633-838425	Cap. F. Cerm, 22pf, 500V	1
C6		Same as C3	
C7		Same as C4	
C8	631-837782	Cap. F. Elect, 1μf, 50V	1
C9	637-819447	Cap. F. Mica, 75pf, 300V	1
C10	631-839718	Cap. F. Elect, 10μf, 20V	1
C11	633-804715	Cap. F. Cerm, 0.01μf, 50V	6
C12 thru C14		Same as C4	
C15	633-836932	Cap. F. Cerm, 100pf, 500V	2
C16		Same as C15	
C17	639-836712	Cap. F. Paper, 0.1μf, 50V	1
C18 thru C22		Same as C11	
CR1	775-402107	Diode, Special, 1N95	1
CR2	755-815561	Diode, Silicon, CD6111	16
CR3		Same as CR2	
CR4	755-420893	Diode, Special	4
CR5		Same as CR4	
CR6		Same as CR2	
CR7		Same as CR4	
CR8		Same as CR2	
CR9	755-404593	Diode, Special	1
CR10 thru CR21		Same as CR2	
CR22		Same as CR4	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
	887-425446	GATE CONTROL P.C. BOARD	
C1	633-838426	Cap, 33 P.F. 500V, 10%	8
C2		Same as C1	
C3	633-804715	Cap, .01μf, 50V	8
C4 thru C6		Same as C1	
C7		Same as C3	
C8	633-838425	Cap., 22P.F. 500V, 10%	3
C9		Same as C1	
C10		Same as C3	
C11		Same as C8	
C12		Same as C1	
C13		Same as C3	
C14		Same as C8	
C15		Same as C1	
C16		Same as C3	
C17	631-837782	Cap, 1μf, 50V	1
C18 thru C20		Same as C3	
CR1	755-420893	DIODE, Special	7
CR2		Same as CR1	
CR3	755-815561	DIODE, CD6111	8
CR4 & CR5		Same as CR1	
CR8 & CR9		Same as CR3	
CR10 & CR11		Same as CR3	
CR12		Same as CR1	
CR13		Same as CR3	
CR14		Same as CR1	
CR15		Same as CR3	
CR16		Same as CR1	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
CR17		Same as CR3	
R1	601-823395	RESISTOR, 470Ω,1/4W, 5%	10
R2	601-822296	RESISTOR, 3.3K, 1/4W, 5%	6
R3		Same as R2	
R4		Same as R1	
R5	601-822371	RESISTOR, 390Ω, 1/4W, 5%	5
R6		Same as R2	
R7	601-822335	RESISTOR, 27K, 1/4W, 5%	4
R8		Same as R7	
R9		Same as R1	
R10 & R11		Same as R2	
R12		Same as R1	
R13		Same as R5	
R14	601-822308	RESISTOR, 1K, 1/4W, 5%	1
R15		Same as R2	
R16 & R17		Same as R7	
R18		Same as R1	
R19	601-822331	RESISTOR, 8.2K, 1/4W, 5%	3
R20	601-822544	RESISTOR, 1.8K, 1/4W, 5%	3
R21		Same as R5	
R22		Same as R1	
R23	601-822301	RESISTOR, 15K, 1/4W, 5%	3
R24		Same as R1	
R25		Same as R19	
R26		Same as R20	
R27		Same as R5	
R28		Same as R1	
R29		Same as R23	
R30		Same as R1	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
	887-426432	PRESET OUTPUT P.C. BOARD	
C1	633-839570	Cap, 39 pf, 500V, 10%	3
C2	633-804715	Cap, 0.01μf, 50V	5
C3	633-838426	Cap, 33 pf, 500V, 10%	6
C4		Same as C3	
C5		Same as C1	
C6		Same as C2	
C7 & C8		Same as C3	
C9		Same as C1	
C10		Same as C2	
C11 & C12		Same as C3	
C13 & C14		Same as C2	
CR1	755-815561	Diode, CD6111	6
CR2		Same as CR1	
CR3	755-420893	Diode, Special	4
CR4 & CR5		Same as CR1	
CR6		Same as CR3	
CR7 & CR8		Same as CR1	
CR9 & CR10		Same as CR3	
R1	601-822331	Resistor, 8.2K, 1/4W, 5%	3
R2	601-822371	Resistor, 390Ω, 1/4W, 5%	3
R3	601-822326	Resistor, 1.2K, 1/4W, 5%	3
R4	601-822308	Resistor, 1K, 1/4W, 5%	3
R5	601-822297	Resistor, 4.7K, 1/4W, 5%	6
R6	601-822301	Resistor, 15K, 1/4W, 5%	4
R7	601-823903	Resistor, 56K, 1/4W, 5%	3
R8		Same as R5	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
R9		Same as R1	
R10		Same as R2	
R11		Same as R3	
R12		Same as R4	
R13		Same as R5	
R14		Same as R6	
R15		Same as R7	
R16		Same as R5	
R17		Same as R1	
R18		Same as R2	
R19		Same as R3	
R20		Same as R4	
R21		Same as R5	
R22		Same as R6	
R23		Same as R7	
	887-426103	DCU W/READOUT	
C1	633-839570	Cap. 39 pf, 500V, 10%	3
C2		Same as C1	
C3		Not used	
C4		Same as C1	
C5		Not used	
C6	633-839569	Cap. 10 pf, 500V, 10%	2
C7		Not used	
C8		Same as C6	
C9	633-839568	Cap. 47 pf, 500V, 10%	10
C10 thru C18		Same as C9	
C19	633-804715	Cap. 0.01μf, 50V	3
C20 & C21		Same as C19	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
CR2	755-815561	Diode, CD6111	12
CR4		Same as CR2	
CR6 thru CR8		Same as CR2	
CR10		Same as CR2	
CR12		Same as CR2	
CR14		Same as CR2	
CR16		Same as CR2	
CR18		Same as CR2	
CR20		Same as CR2	
CR21	755-402107	Diode, Special	17
CR22 thru CR36		Same as CR21	
CR41		Same as CR21	
CR50		Same as CR2	
Q1	755-425735	Transistor, Special	9
Q2		Same as Q1	
Q5 thru Q11		Same as Q1	
Q12	755-838105	Transistor, 2N3638	6
Q13	755-422494	Transistor, Special	6
Q14	755-817964	Transistor, 2N1420	2
Q15		Same as Q14	
Q16		Same as Q12	
Q17		Same as Q13	
Q18		Same as Q12	
Q19		Same as Q13	
Q20		Same as Q12	
Q21		Same as Q13	
Q22		Same as Q12	
Q23		Same as Q13	
Q24		Same as Q12	
Q25		Same as Q13	

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
R1	601-015444	Resistor, 390Ω, 1/2W, 5%	1
R2	601-822299	Resistor, 6.8K, 1/4W, 5%	1
R4 thru R7	601-822324	Resistor, 10K, 1/4W, 5%	4
R8	601-823381	Resistor, 15Ω, 1/4W, 5%	1
R10	601-823397	Resistor, 5.6K, 1/4W, 5%	6
R11 thru R15		Same as R10	
RM1	885-425909	Resistor Module	5
RM2 thru RM5		Same as RM1	
RM6	885-425908	Resistor Module	2
RM7		Same as RM6	
RM8	885-425906	Resistor Module	6
RM9	885-425907	Resistor Module	1
RM10 thru RM14		Same as RM8	
	887-426107	DCU WITHOUT/ READOUT	
C1	633-839570	Cap. 39 pf, 500V, 10%	3
C2 & C4		Same as C1	
C6	633-839569	Cap. 10 pf, 500V, 10%	2
C8		Same as C6	
C9	633-839568	Cap. 47 pf, 500V, 10%	10
C10 thru C18		Same as C9	
C19	633-804715	Cap., 0.01μf, 50V	3
C20 & C21		Same as C19	
CR2	755-815561	Diode, CD6111	12
CR4		Same as CR2	
CR6 thru CR8		Same as CR2	
CR10		Same as CR2	
CR12		Same as CR2	
CR14		Same as CR2	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
CR16		Same as CR2	
CR18		Same as CR2	
CR20		Same as CR2	
CR29		Same as CR2	
R1	601-015444	Resistor, 390Ω, 1/2W, 5%	1
R2	601-822299	Resistor, 6.8K, 1/4W, 5%	1
RM1	885-425909	Resistor, Module	5
RM2 thru RM5		Same as RM1	
RM6	885-425908	Resistor Module	2
RM7		Same as RM6	
Q1	775-425735	Transistor, Special	9
Q2		Same as Q1	
Q5 thru Q11		Same as Q1	
	887-424010	100KC/1MC OSCILLATOR P.C. BOARD	
C1	633-804715	Cap. F. Cerm, 0.01μf, 50V	7
C2	651-829170	Cap. F. Mylar, 0.22μf, 50V 20%	1
C3		Same as C1	
C4	637-825813	Cap. F. Mica, 270pf, 500V, 5%	1
C5	637-824301	Cap. F. Mica, 2000pf, 300V, 5%	1
C6	631-837782	Cap. F. Elect 1μf, 50V	1
C7 thru C9		Same as C1	
C10	637-824498	Cap. F. Mica, 150pf, 300V	1
C11		Same as C1	
C12	637-825349	Cap. F. Mica, 560pf, 500V, 5%	1
C13		Same as C1	
CR1	755-811280	Diode, Silicon, Type CD3319	1
CR2	755-402107	Diode, Special	1
L1	795-807875	Inductor, F. R.F., 6.8μh	1

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
Q1	755-422494	Transistor, Type 422494	1
Q2	755-419596	Transistor, Special	1
Q3	755-817811	Transistor, Type 2N961, German	2
Q4		Same as Q3	
Q5	755-823113	Transistor, Type 2N2219	1
R1	601-822324	Res. F. Comp, 10K, 1/4W, 5%	3
R2	601-822334	Res. F. Comp. 22K, 1/4W, 5%	1
R3 & R4		Same as R1	
R5	601-822308	Res. F. Comp, 1K, 1/4W, 5%	4
R6		Same as R5	
R7	611-806245	Res. V. W.W., 5K, 2W, 10%	1
R8	601-822295	Res. F. Comp, 2.7K, 1/4W, 5%	2
R9	601-817735	Res. F. Comp, 100Ω, 1/4W, 5%	2
R10		Same as R5	
R11	601-801803	Res. F. Comp. 12K, 1/4W, 5%	1
R12	601-822327	Res. F. Comp, 220Ω 1/4W 5%	1
R13		Same as R5	
R14	601-822544	Res. F. Comp, 1.8K, 1/4W, 5%	1
R15	601-822306	Res. F. Comp, 820Ω, 1/4W, 5%	3
R16		Same as R9	
R17		Same as R8	
R18	601-822326	Res. F. Comp, 1.2K, 1/4W, 5%	1
R19 & R21		Same as R15	
		OSCILLATOR ASSEMBLY	
C4	655-808212	Cap. Variable, 0.6-14pf	1
C5	633-804717	0.01μf. 50VDC Cap.	1
C6	633-812052	56pf, Cerm. Cap.	1
F1	881-401955	100 KC Crystal	1
R1	601-822371	Resistor, 390Ω, 1/4W, 5%	1

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
R2	601-822326	Resistor, 1.2K, 1/4W, 5%	1
S7	716-827410	EXT-INT, Switch	
XF1	735-007268	Crystal Socket	1
		POWER SUPPLY COMPONENTS	1
C1	631-423957	Capacitor, 920pf, 50V	1
C2	631-423959	Capacitor, 3000pf, 25V	1
C3	631-423958	Capacitor, 1800pf, 50V	1
CR1	774-824972	Bridge Rectifier	2
CR2	774-824971	Bridge Rectifier	1
CR3		Same as CR1	
E1	691-836661	Block, Terminal (8pos.)	1
E2	691-836659	Block, Terminal (2 pos.)	1
T1	792-423956	Transformer, Power	1
XA1	680-824871	Connector, 15 Pin (Cinch)	1
L1	795-423953	Inductor	1
L2	795-423954	Inductor	1
L3	795-423955	Inductor	1
	771-423828	Filter Line	1
	327-419568	P.C. Bd. Support, Mod.	2
		MISCELLANEOUS	
	449-426138	Front Panel	1
	327-424293	Switch Bracket	1
	704-838151	Switch (Reset)	1
	711-425471	Switch (Gate)	1
	711-425917	Switch (Function)	1
	010-425621	Bottom Cover	1
	115-425594	Stud Ass'y (CAMLOC #2753-5)	1
	443-425426	Front Panel Readout	1
	443-425427	Front Panel Readout	1

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
	443-425428	Front Panel Readout	1
	297-426016	Top Cover	1
	433-423456	Left Dress Panel	1
	433-425447	Right Front Panel	1
	443-425448	Right Front Panel	1
	443-425449	Right Front Panel	1
	433-420427	Right Dress Panel	1
	716-838152	Reset Lens Cap. Ass'y	1
	325-420982	Knob	1
	330-420770	Handle	1
	858-425732	Extension Board	1
	010-425669	Lamp Block & Bezel Ass'y	1
	349-423453	Right Side Panel	1
	349-423451	Left Side Panel	1
	327-423740	Connector Brackets	1
	680-424115	P.C. Board Connectors (Dual)	1
	680-823481	P.C. Board Connectors (Single)	1
	433-425483	Rear Panel	1
	349-420000	Rear Trim	1
	161-421927	Fan Spacer	1
	855-424415	Power Supply Ass'y	1
	010-421881	Ass'y Fan & Shroud	1
	664-812450	Line Cord	1
	735-007268	Fuse Holder	1

Detail No.	Beckman Stock No.	Description	Qty. / Ass'y
	697-420945	Lamp Block Connector Ass'y	1
	731-801567	Fuse (1.5 Amp, SloBlo)	1
	010-423797	Chassis	1

LOGIC SYMBOLS AND TYPICAL CIRCUITS

This section describes logic symbols as used in this manual. Typical circuit configurations are shown with each symbol. Actual circuits used in this instrument may be modifications of these typical circuits.

A.1 AND GATE

The AND gate is a multiple-input circuit which requires that all inputs be present in order to produce an output.

A typical AND gate is shown in figure A-1.

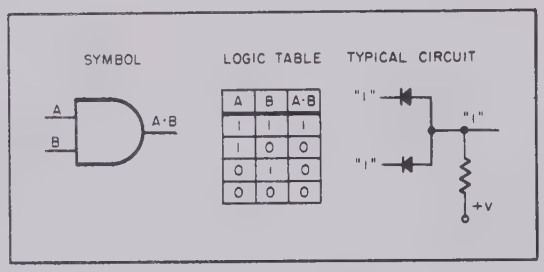


Fig. A-1. AND Gate

A.2 OR GATE

The OR gate requires the presence of one or more inputs in order to produce an output.

A typical OR gate is shown in figure A-2.

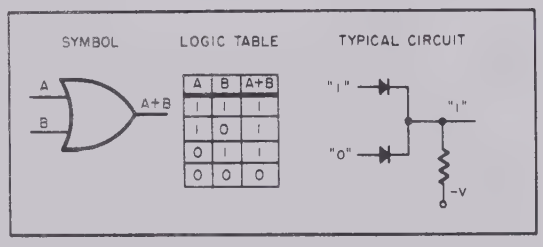


Fig. A-2. Typical OR Gate

A.3 NAND GATE

The NAND gate is a multiple-input circuit which requires all inputs to be logic 1 in order to produce a logic 0 output.

A typical NAND gate is shown in figure A-3.

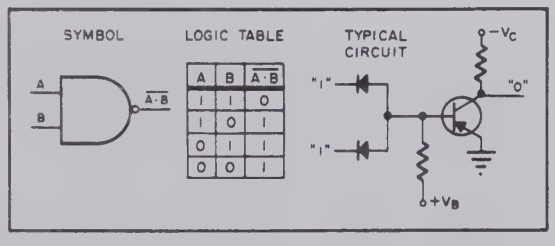


Fig. A-3. Typical NAND Gate

A.4 NOR GATE

The NOR gate is a multiple-input circuit which requires all inputs to the gate to be logic 0 to produce a logic 1 output.

A typical NOR gate is shown in figure A-4.

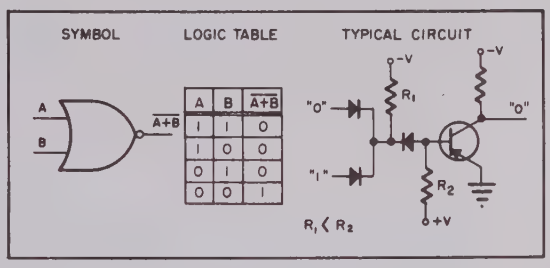


Fig. A-4. Typical NOR Gate

A.5 POSITIVE AND NEGATIVE ZONE LOGIC

Unless stated otherwise, all logic symbols used in this publication refer to positive zone logic. Positive and negative zone logic are defined as follows.

1) Positive Zone Logic:

Positive zone logic exists when all pulses and/or levels occur on the positive side of the zero line.

When logic 1 is more positive than logic 0, it is called "positive zone, positive true". When logic 1 is less positive than logic 0, it is called "positive zone, negative true".

2) Negative Zone Logic:

Negative zone logic exists when all pulses and/or levels occur on the negative side of the zero line.

When logic 1 is less negative than logic 0, it is called "negative zone, positive true". When logic 1 is more negative than logic 0, it is called "negative zone, negative true".

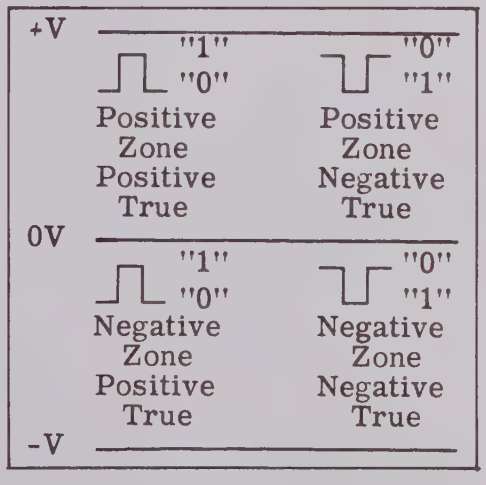


Fig. A-5. Positive and Negative Zone Logic

A.6 INVERTERS AND EMITTER FOLLOWERS

Logic inverting circuits provide a method of converting a logic 0 to a logic 1 or vice versa. Figure A-6 shows the inversion operation and a typical inverting circuit.

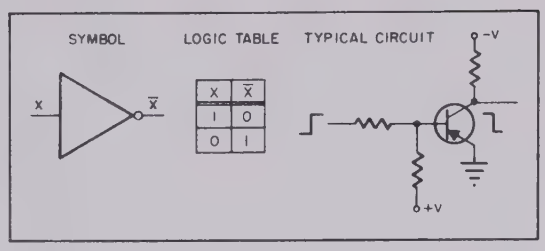


Fig. A-6. Typical Inverter

An emitter follower circuit is represented by the ▷ symbol (see figure A-6A). The circuit is so named because the output at the emitter follows the input in phase. This circuit may be used as a current amplifier or as a coupling or impedance matching element.

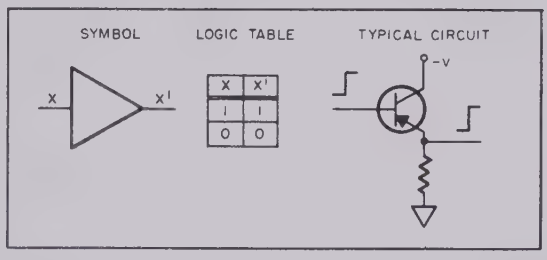


Fig. A-6A. Typical Emitter Follower

A.7 INVERTED TRUE INPUTS

When one input to a logic circuit requires a negative true signal where a positive true signal is usually required, a "not" (o) indication is shown at the particular input terminal of the logic symbol.

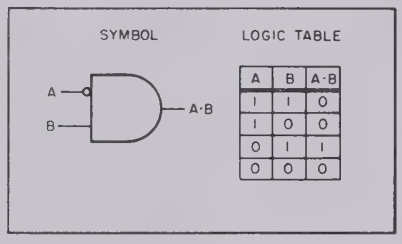


Fig. A-7. AND Gate Using Inverter Control Voltage Level

A.8 FLIP-FLOPS

The bistable multivibrator, or flip-flop, is characterized by having two states, logic 1 or logic 0. Since both states are stable, the binary is commonly used in memory circuits, counting circuits, and shift registers.

A typical flip-flop is shown in figure A-8. In the usual configuration, there are two input lines (logic 1 and logic 0) and two outputs (logic 1 and logic 0).

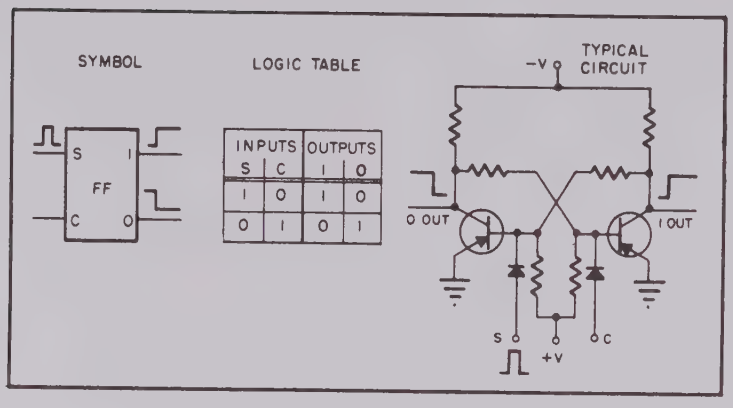


Fig. A-8. Typical Flip-Flop

A signal applied to the set input results in a logic 1 signal at the logic 1 output and a logic 0 signal at the logic 0 output. Conversely, a signal applied to the clear input results in a logic 0 at the logic 1 output and a logic 1 at the logic 0 output.

Positive Pulse Steering

Shown in figure A-8A is a flip-flop using PNP transistors and positive pulse steering. The circuit can exist in either of two stable states: Q1 on, Q2 off; or Q1 off, Q2 on.

Positive input pulses trigger the binary from one stable state to the other through one of the pulse-steering diodes (CR1 or CR2).

Circuit Description

With Q1 conducting and Q2 cut off, a positive input pulse passes through CR1 to the base of Q1. This turns Q1 off. As Q1 turns off, load current decreases and the collector potential approaches -15 volts. This negative transient is coupled through capacitor C1 to the base of Q2, turning Q2 on. Current through Q2 increases and its collector potential rises toward ground. Under these conditions, divider network R6-R4 maintains a positive potential at the base of Q1 to keep it cut off.

The flip-flop remains in this stable state (Q1 off, Q2 on) until the next positive input arrives. At this time, Q2 cuts off, Q1 conducts, and the binary resumes its original state.

NOTE

Logic 1 and logic 0 inputs may also be referred to as set and clear inputs.

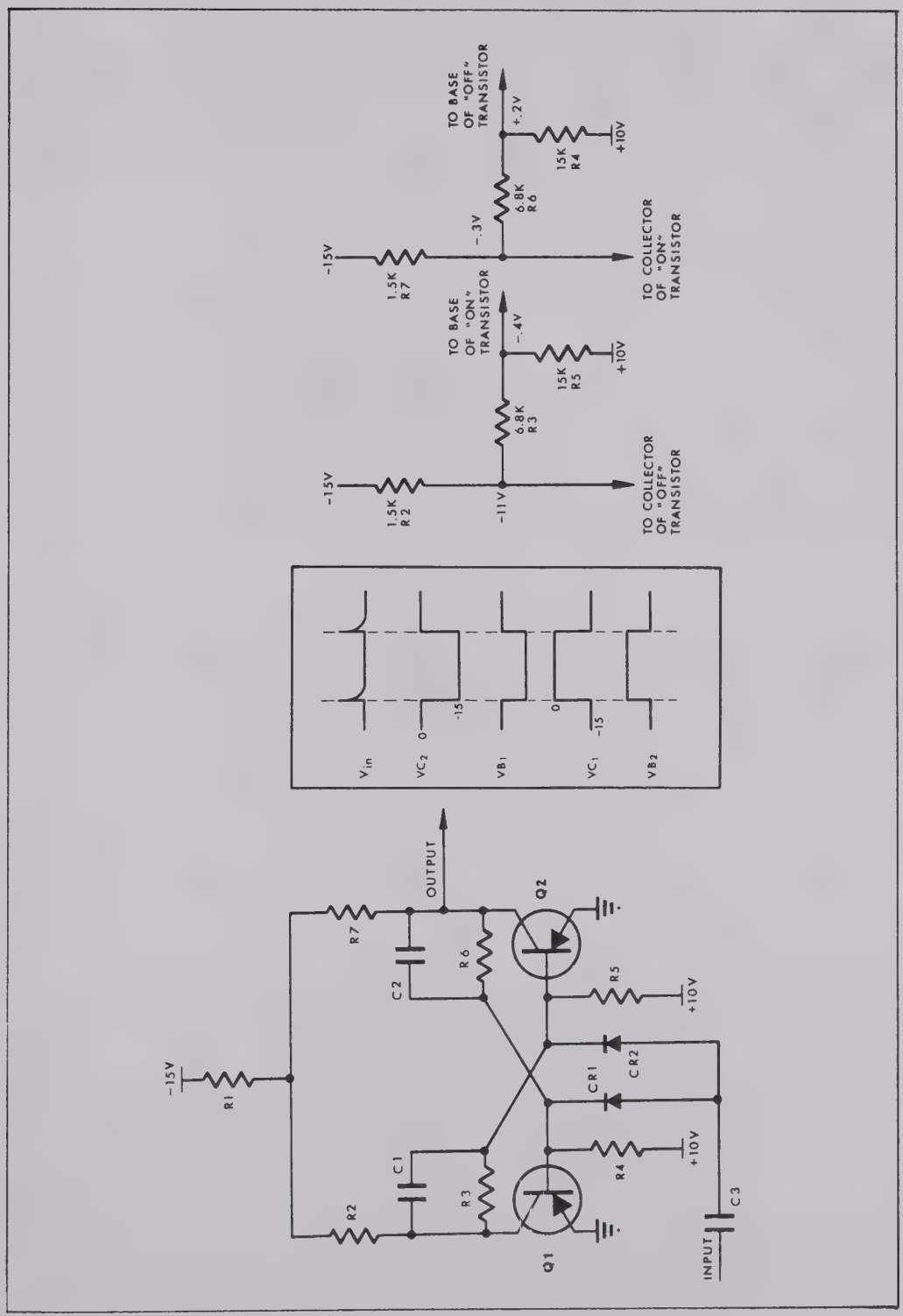


Fig. A-8A. Positive Pulse Steering

A.9 SINGLE-SHOT (MONOSTABLE) MULTIVIBRATOR

A typical single-shot (monostable) multivibrator is shown in figure A-9. Transistor Q1 is held at cutoff and transistor Q2 at saturation by bias arrangement and transistor regeneration. When a negative pulse is applied at the input, the circuit functions until a full cycle is complete. Circuit timing is determined by the values of capacitor C1 and resistor R2.

Single-Shot Circuit Description

A negative pulse is applied through coupling capacitor C2 to the base of transistor Q1, and it begins to conduct. The negative voltage at the collector of Q1 begins to fall. This positive transient is coupled to the base of transistor Q2, and forward bias on Q2 is decreased. Collector current of Q2 begins to decrease, and its collector voltage increases negatively. Part of this voltage is coupled through R4 to the base of Q1, increasing its negative potential. This regeneration results in a rapid change of both transistors; it drives Q1 into saturation and Q2 into cutoff. Since capacitor C1 was initially charged to -15 volts, the base of Q2 is at a positive potential of that magnitude (15 volts).

Capacitor C1 beings to discharge through R2 and the low resistance of Q1, and base potential of Q2 becomes less positive. When the base of Q2 becomes slightly negative, Q2 again conducts. Collector potential of Q2 increases positively and is coupled to the base of transistor Q1, driving it to cutoff. Transistor Q1 is again at cutoff and Q2 at saturation. This stable state is maintained until another negative pulse arrives to trigger the circuit.

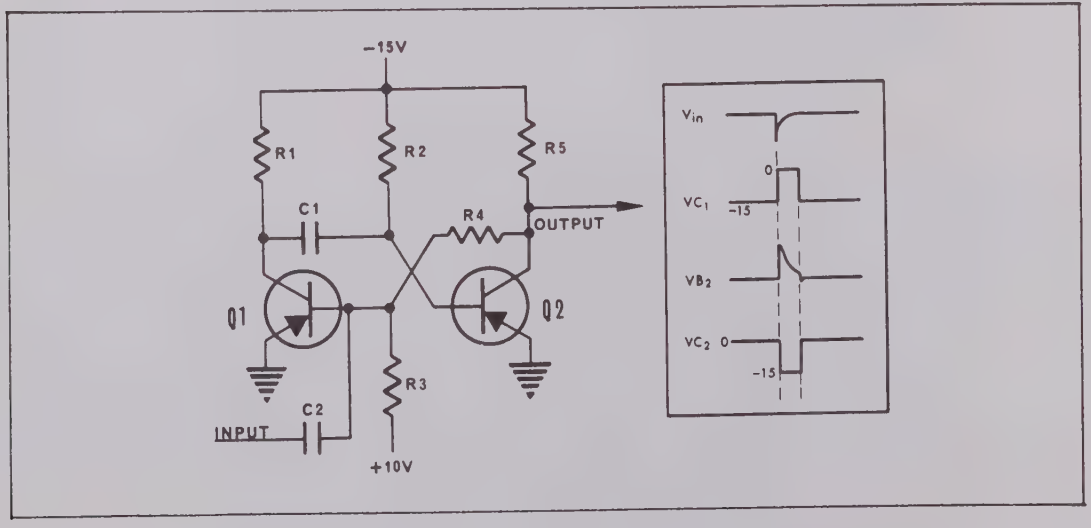
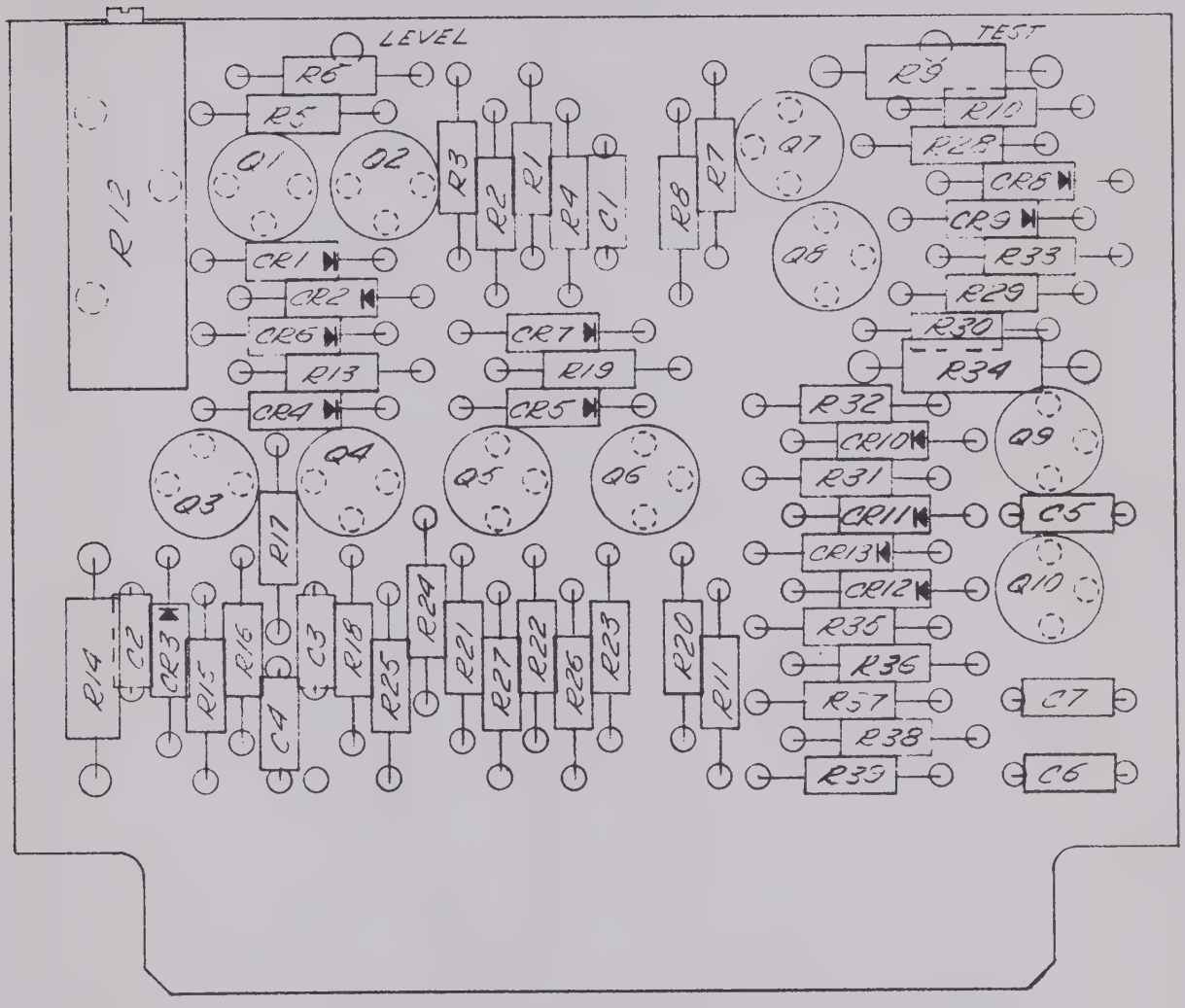
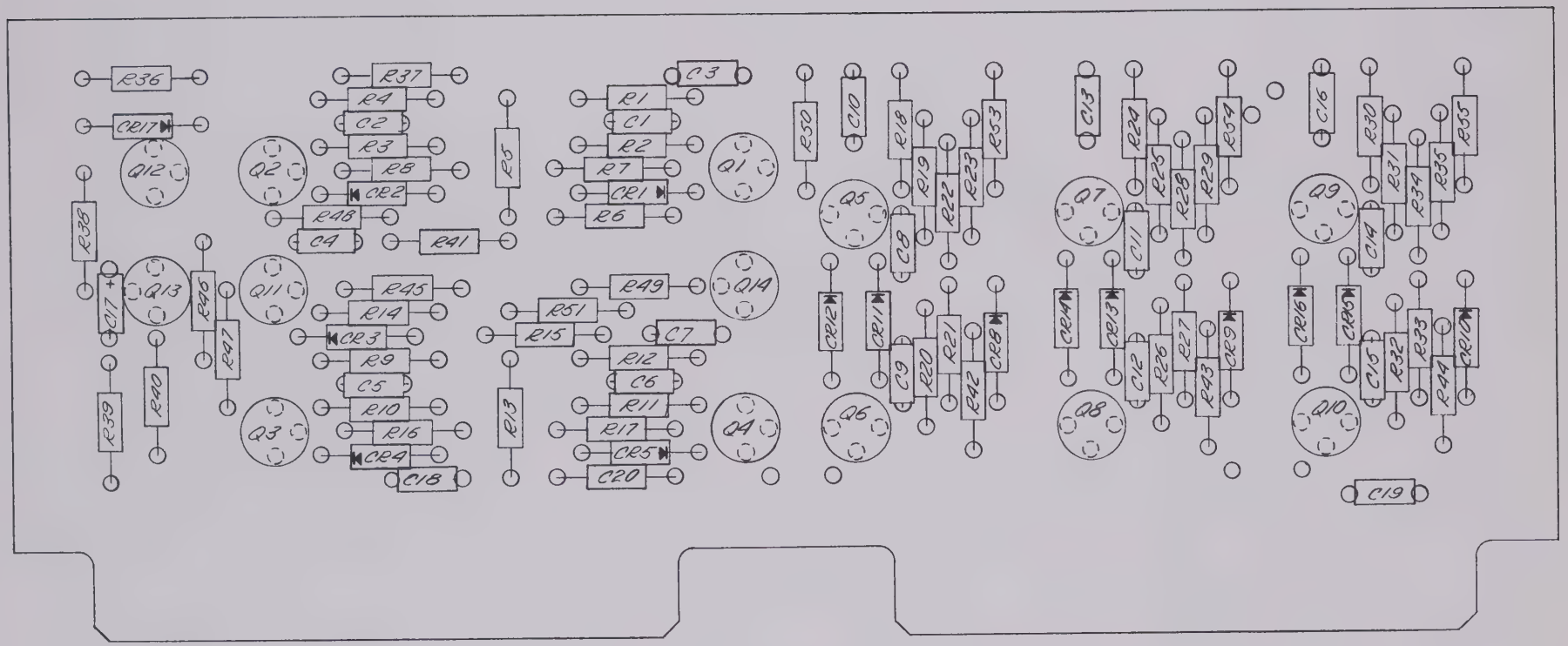


Fig. A-9. Typical Single-Shot Circuit



INPUT AMPLIFIER P.C. BOARD

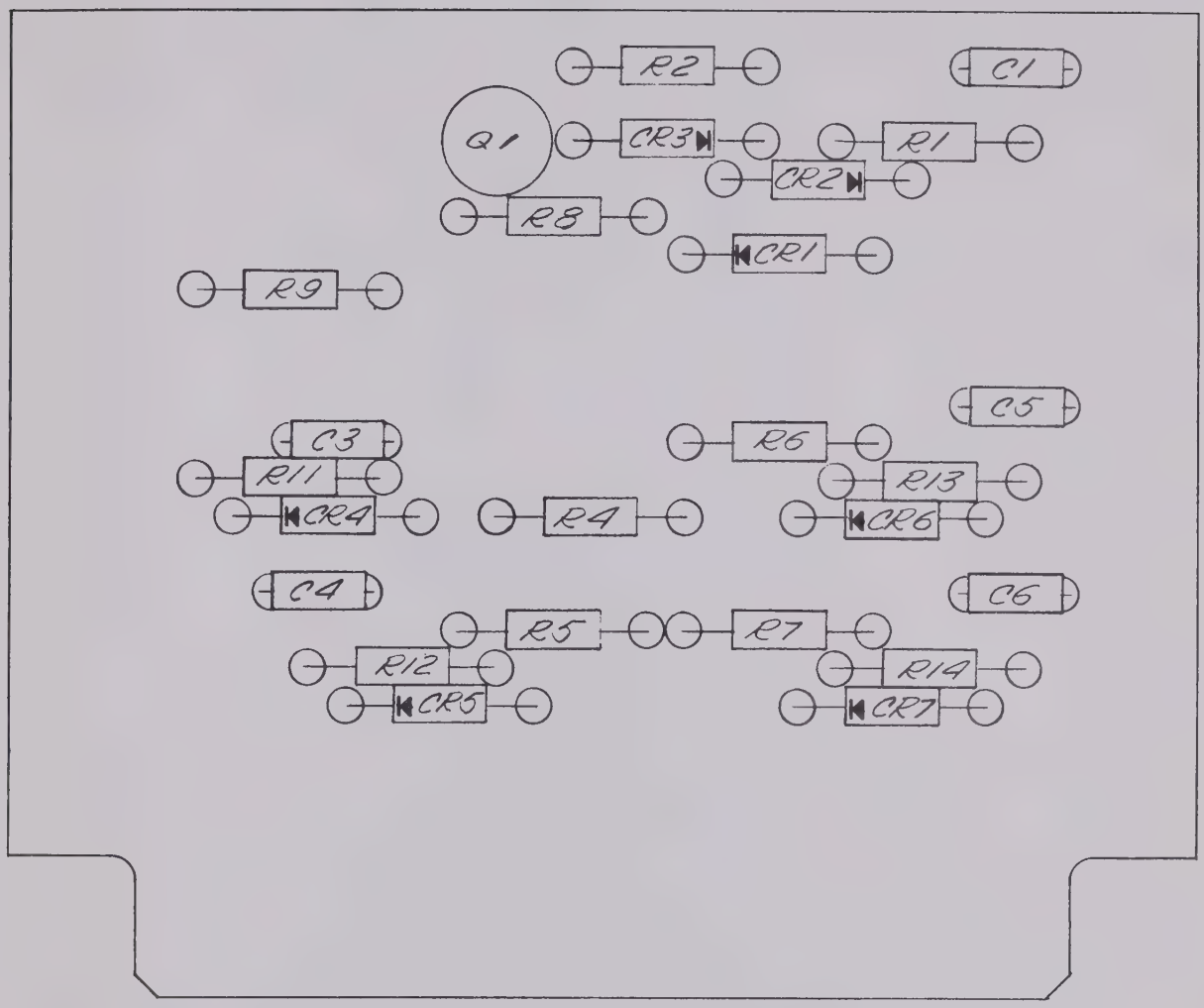
Beckman



GATE CONTROL P.C. BOARD

Model 6020
D 425446-Rev. B
September 1965

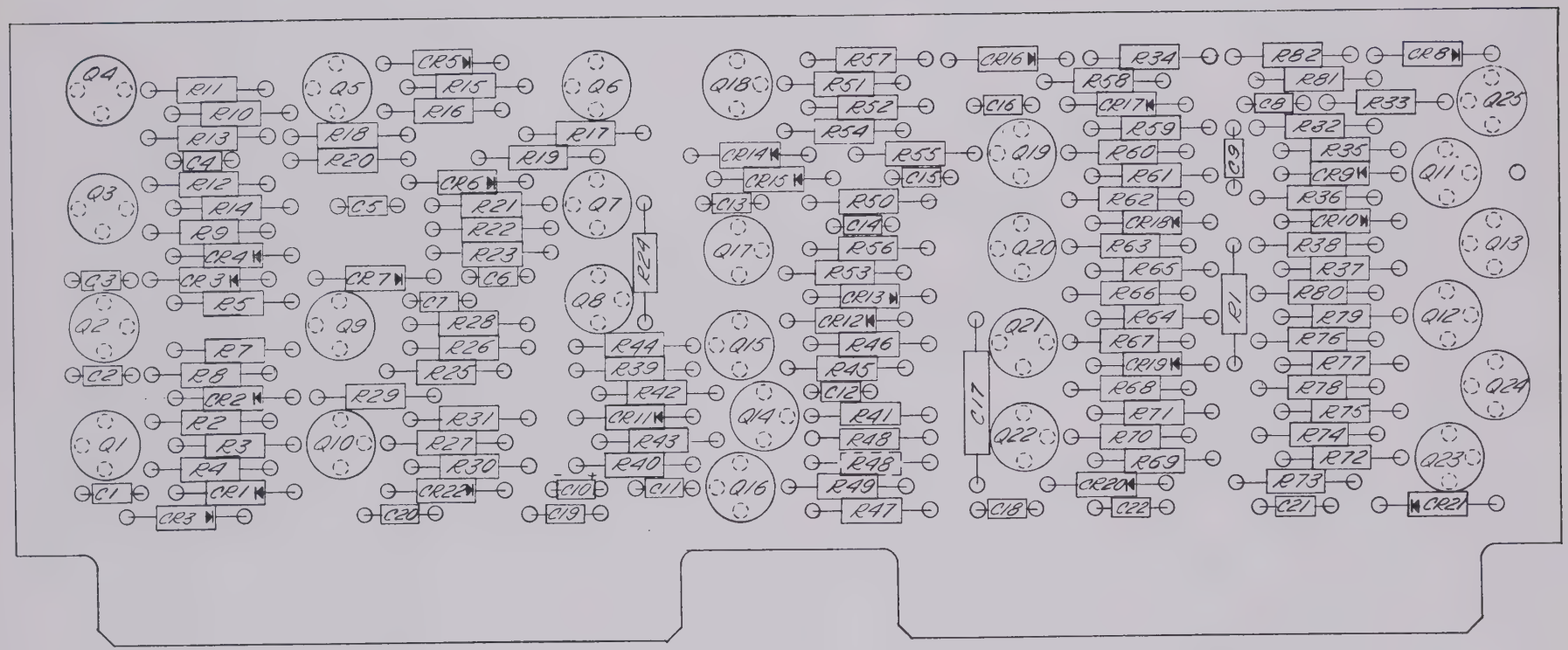
Beckman



TIME BASE LOGIC P.C. BOARD

Model 6020
C 424721-Rev. A
September 1965

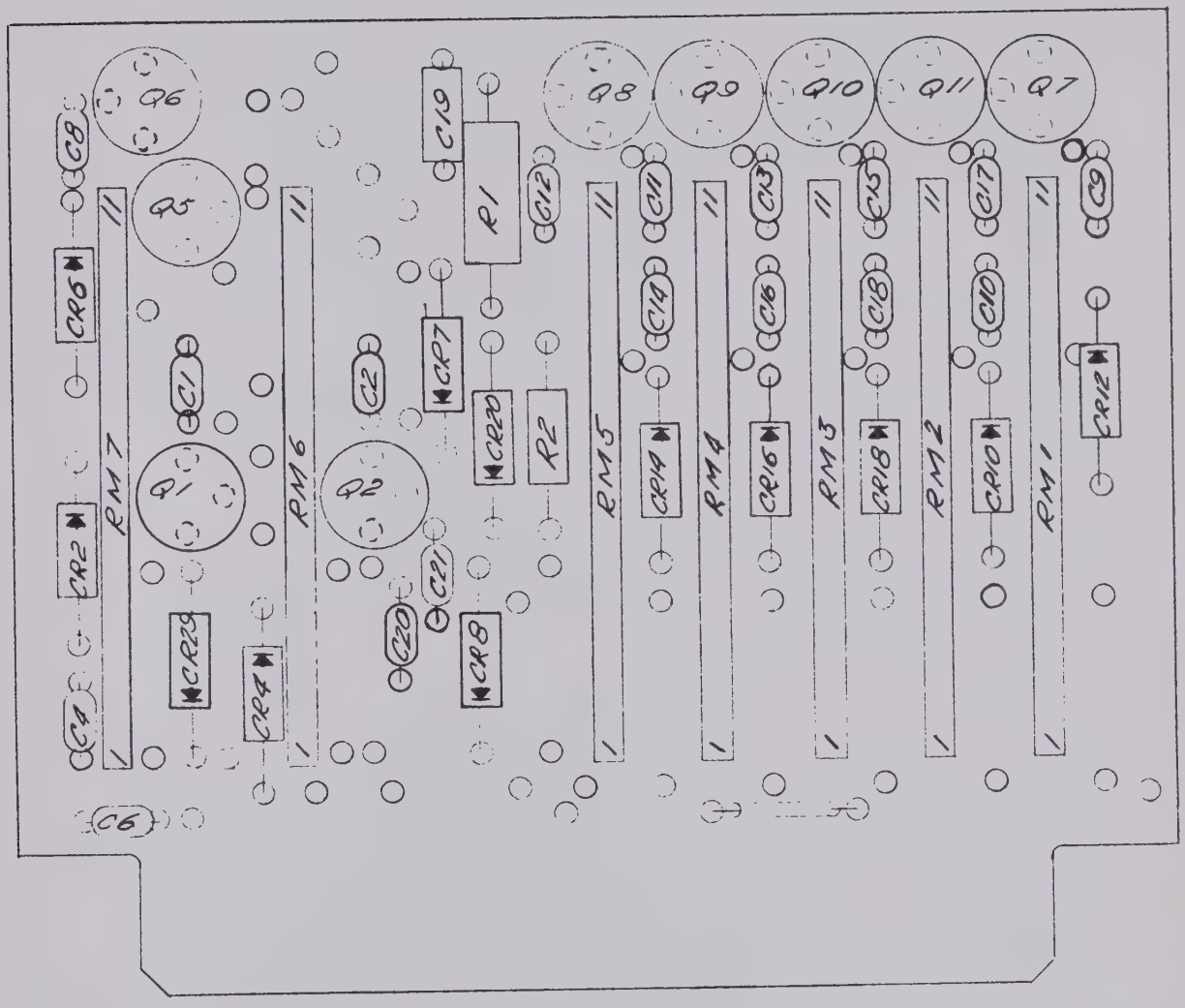
Beckman



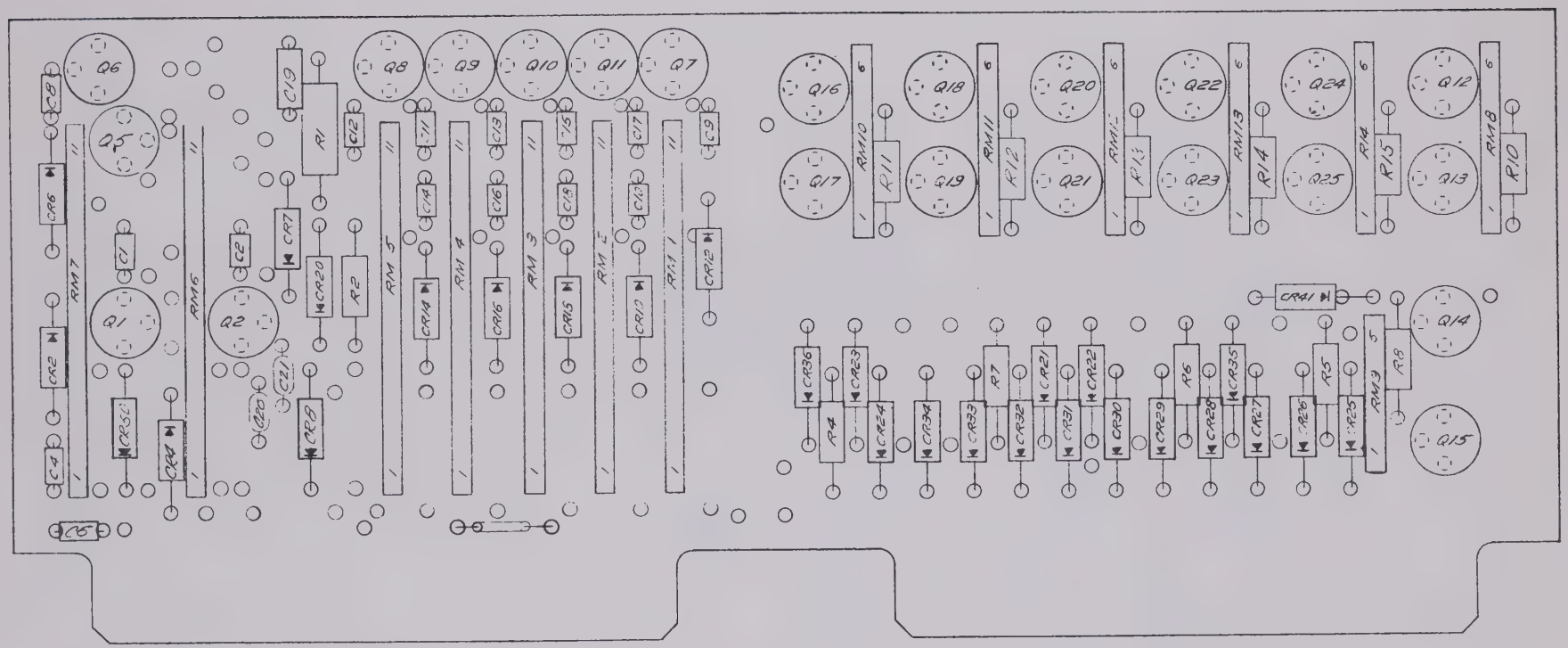
TIMING CONTROL P.C. BOARD

Model 6020
D-42651-Rev A
September 1965

Beckman

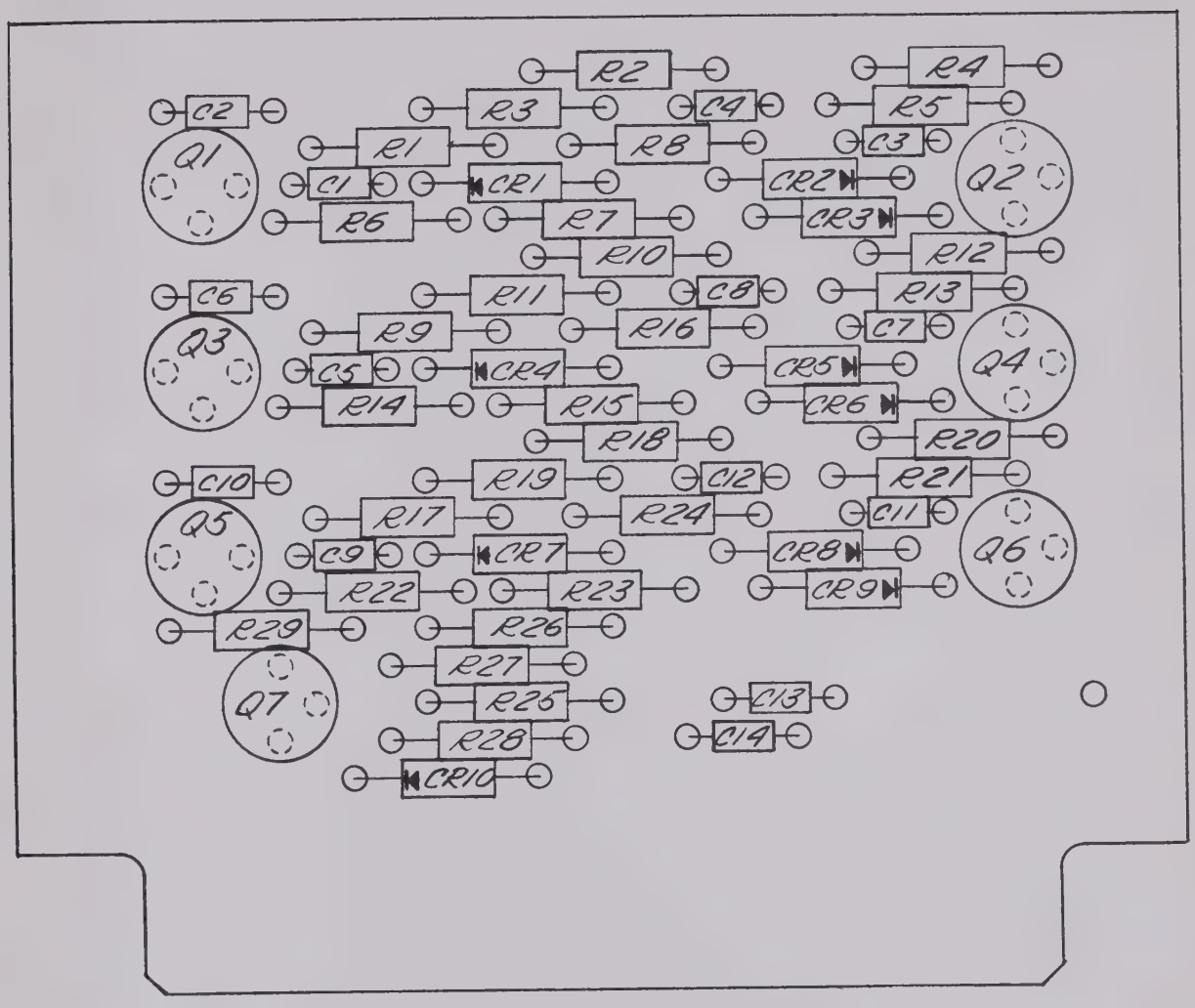


BI-QUINARY DCU without READOUT (FORWARD ONLY) P.C. BOARD



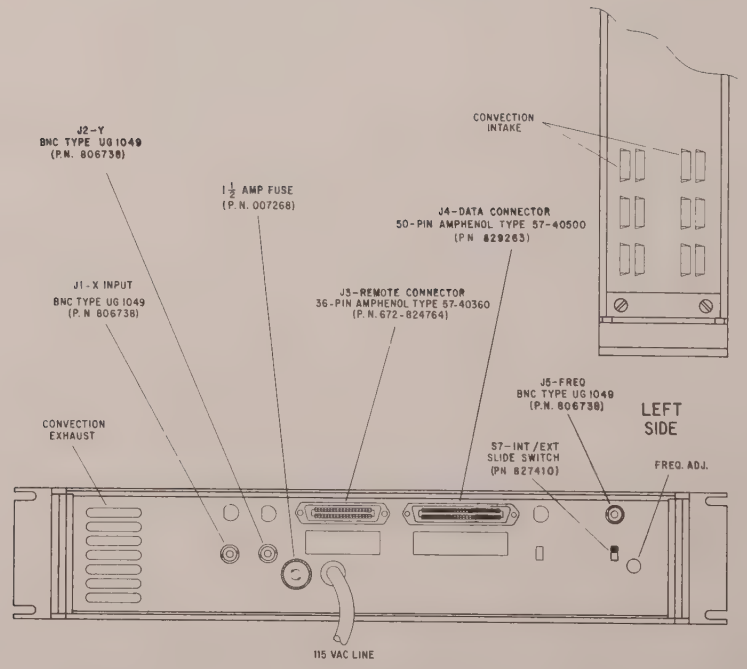
BI-QUINARY DCU with READOUT (FORWARD ONLY) P.C. BOARD

Model 6020
C 426103-Rev. A
September 1965
Beckman

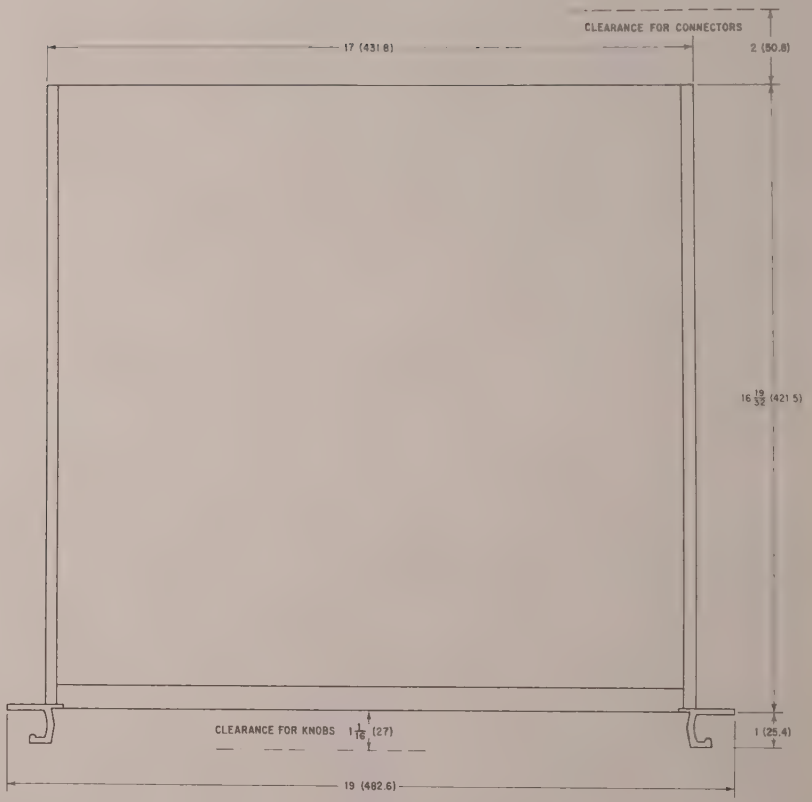


PRESET/OUTPUT P. C. BOARD

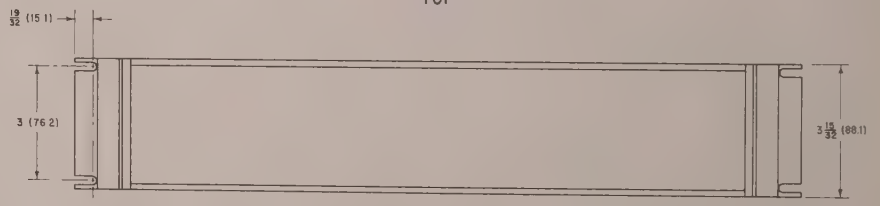
OUTLINE DRAWING



REAR



TOP

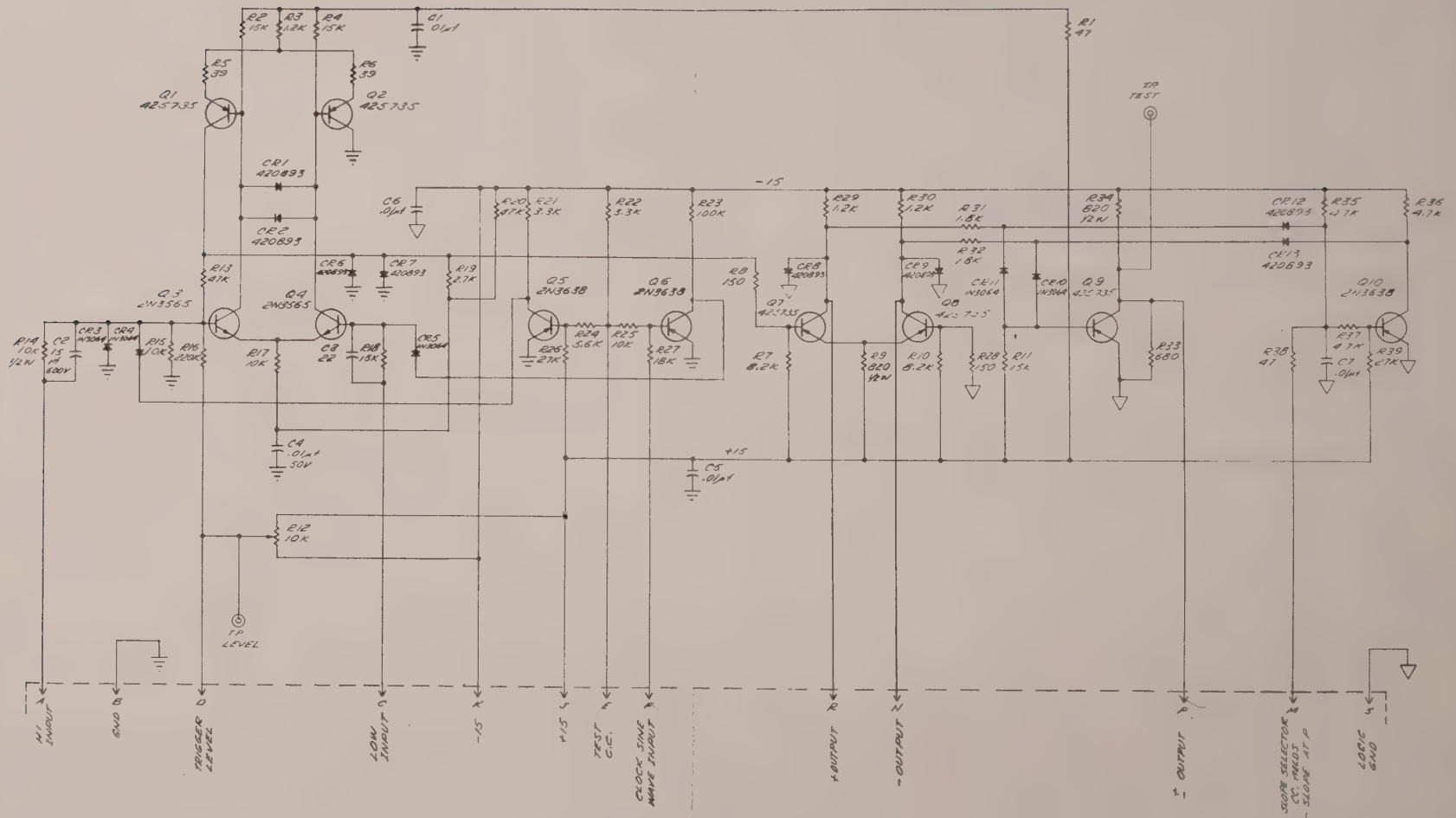


FRONT

Model 6020
63-C-6020
September 1965

Beckman®

INPUT AMPLIFIER
SCHEMATIC DIAGRAM

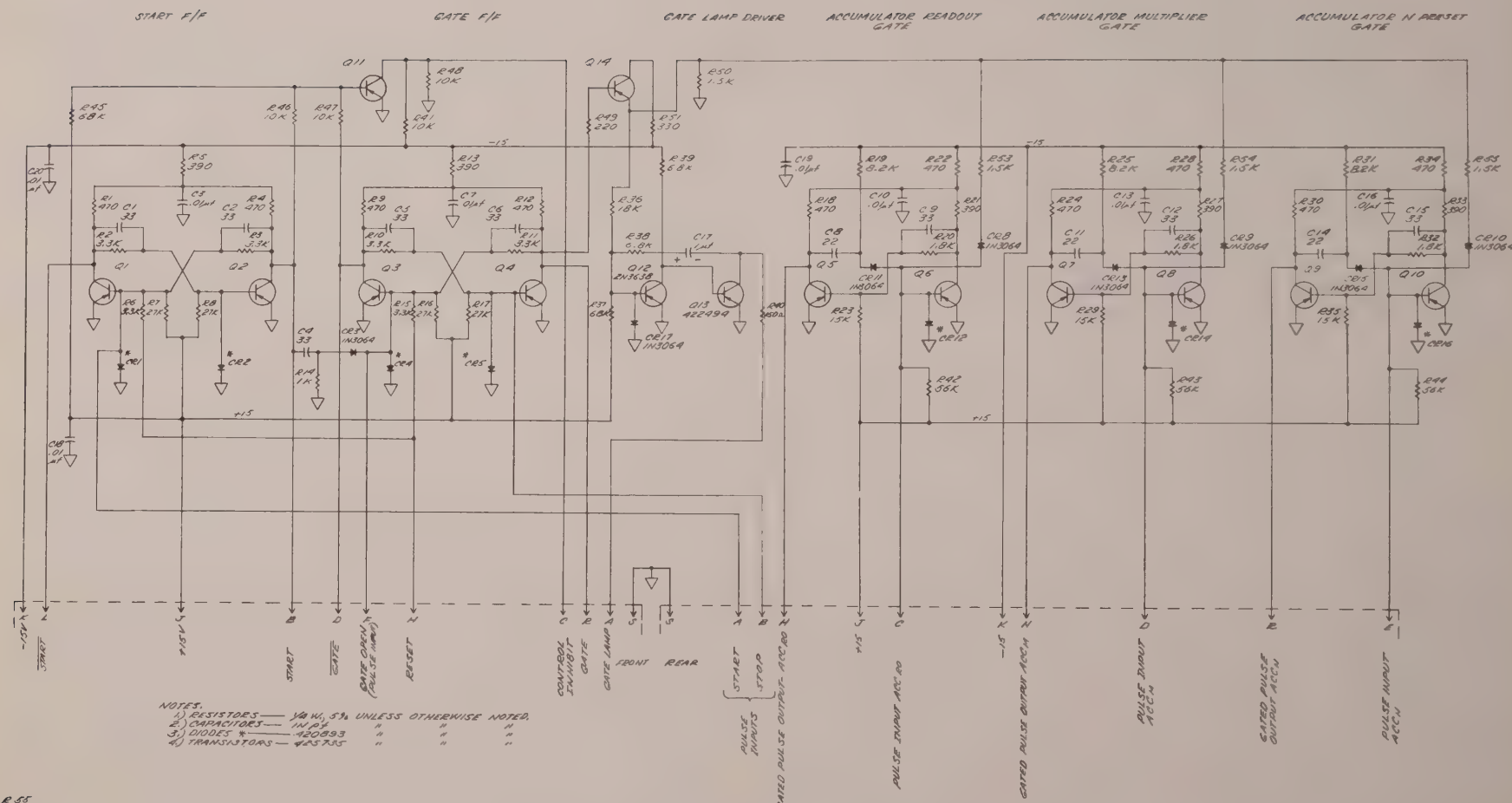


NOTE:
RESISTORS: 1/8 W, 5% UNLESS OTHERWISE NOTED

Model 6020
D426510-Rev. A
September 1965

Beckman

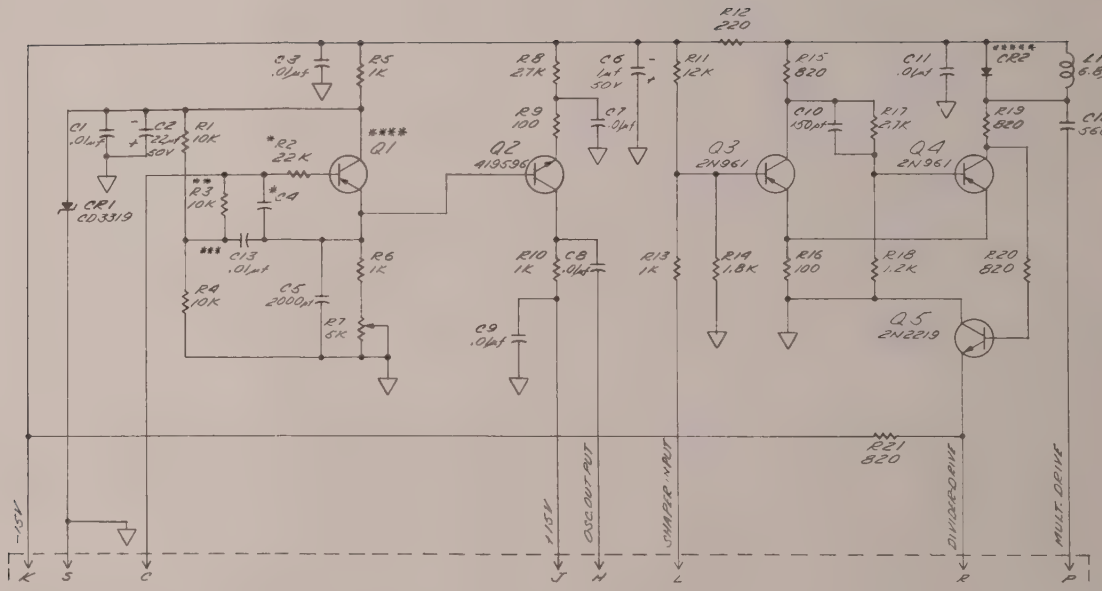
GATE CONTROL
SCHEMATIC DIAGRAM



R 55
C 20
CR 17
Q 14

OMITTED - R52, CR1, 7

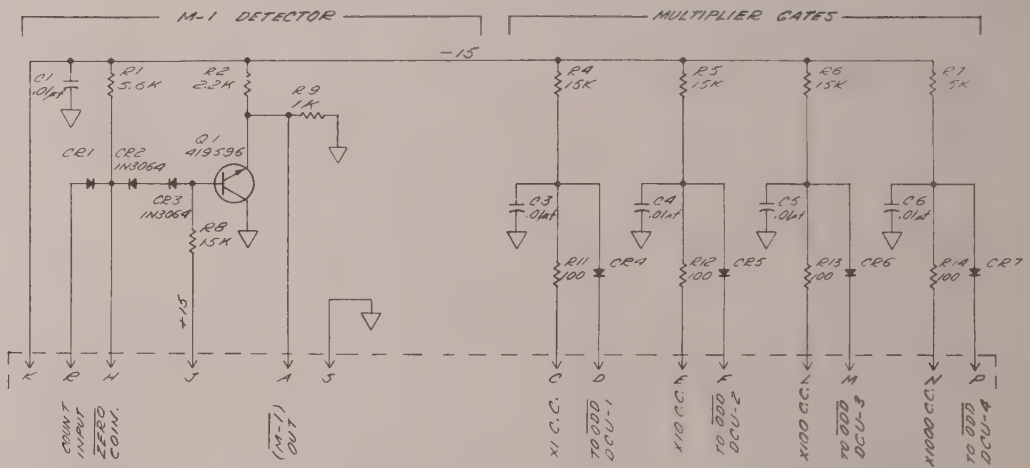
100 KC/1MC OSCILLATOR
SCHEMATIC DIAGRAM



NOTES:
1.) RESISTORS — ½W., 5% UNLESS OTHERWISE NOTED.
2.) * BUSS BAR FOR 1MC
* C4 = 2000μf DM FOR 1MC
* C4 = 270 μf DM FOR 100 KC
3.) ** BUSS BAR FOR 1MC
4.) *** DELETE FOR 1MC
5.) **** BECKMAN SPEC #755-422494
6.) ***** BECKMAN SPEC #755-402107

Model 6020
C 424009-Rev. A
September 1965

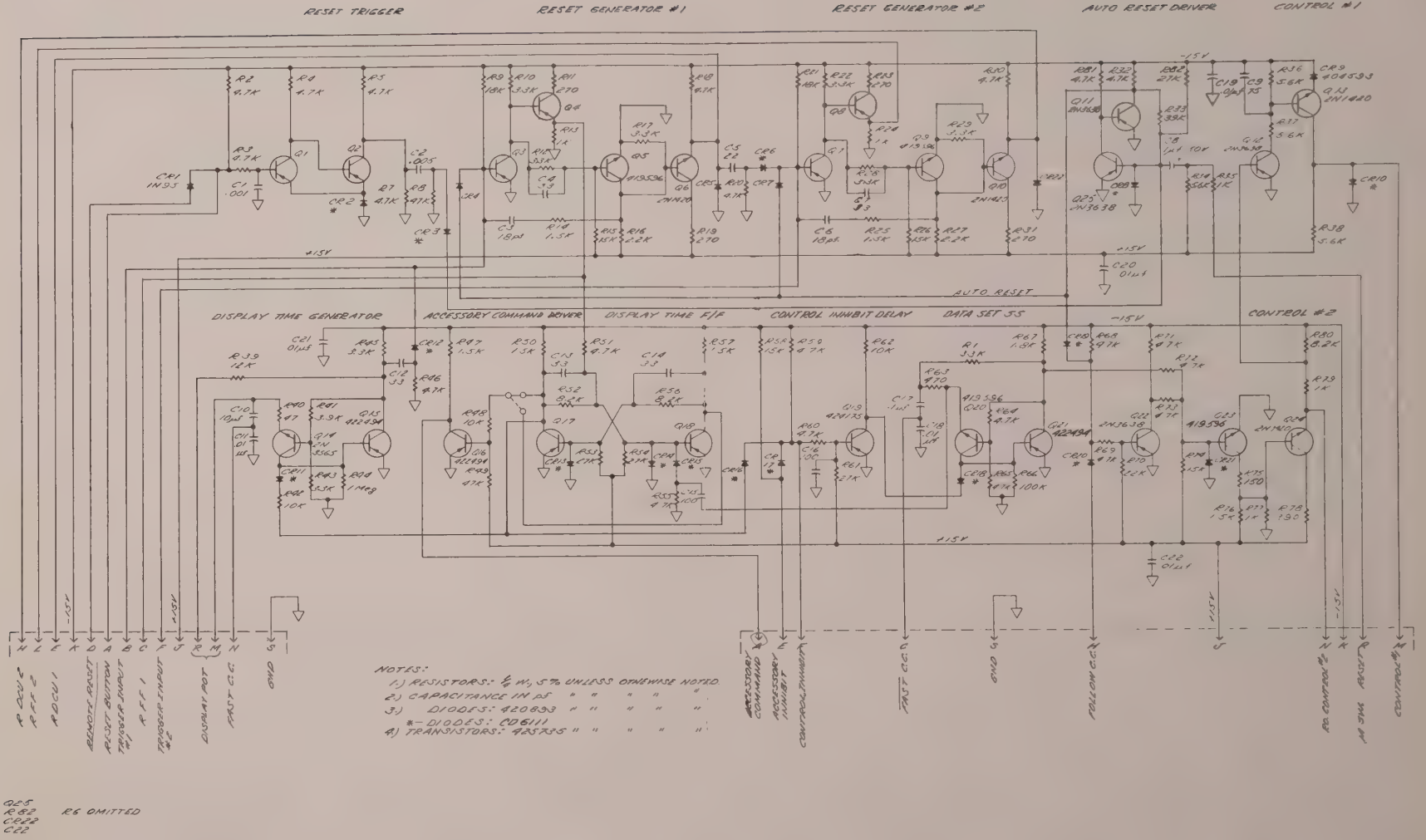
Beckman®



NOTE:
1.) RESISITORS— ¼W, 5% UNLESS OTHERWISE NOTED
2.) CAPACITORS— IN μf " " "
3.) DIODES — BB420893 " " "

OMITTED:
C2, R3
R10

TIMING CONTROL
SCHEMATIC DIAGRAM



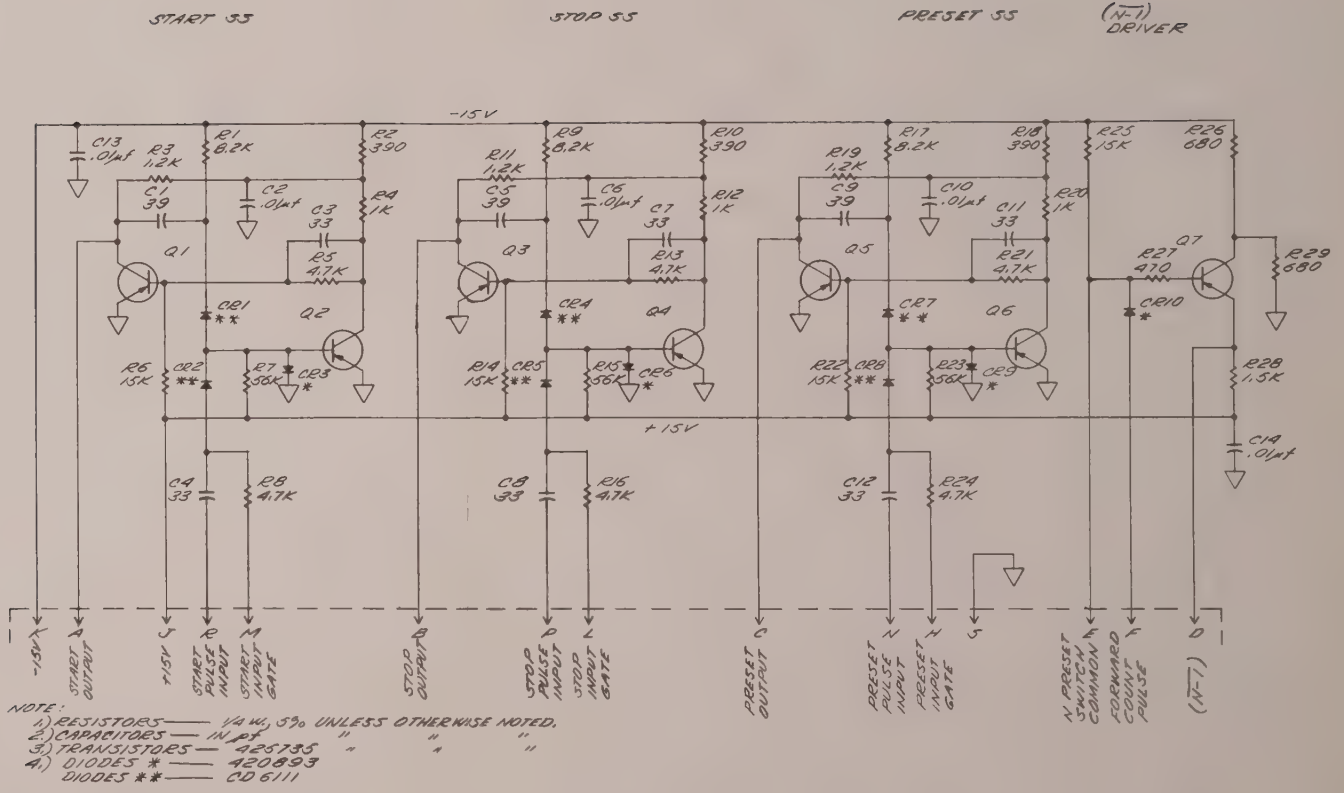
Q25
R82
C822
C22

R6 OMITTED

Model 6020
D 424380-Rev. A
September 1965

Beckman®

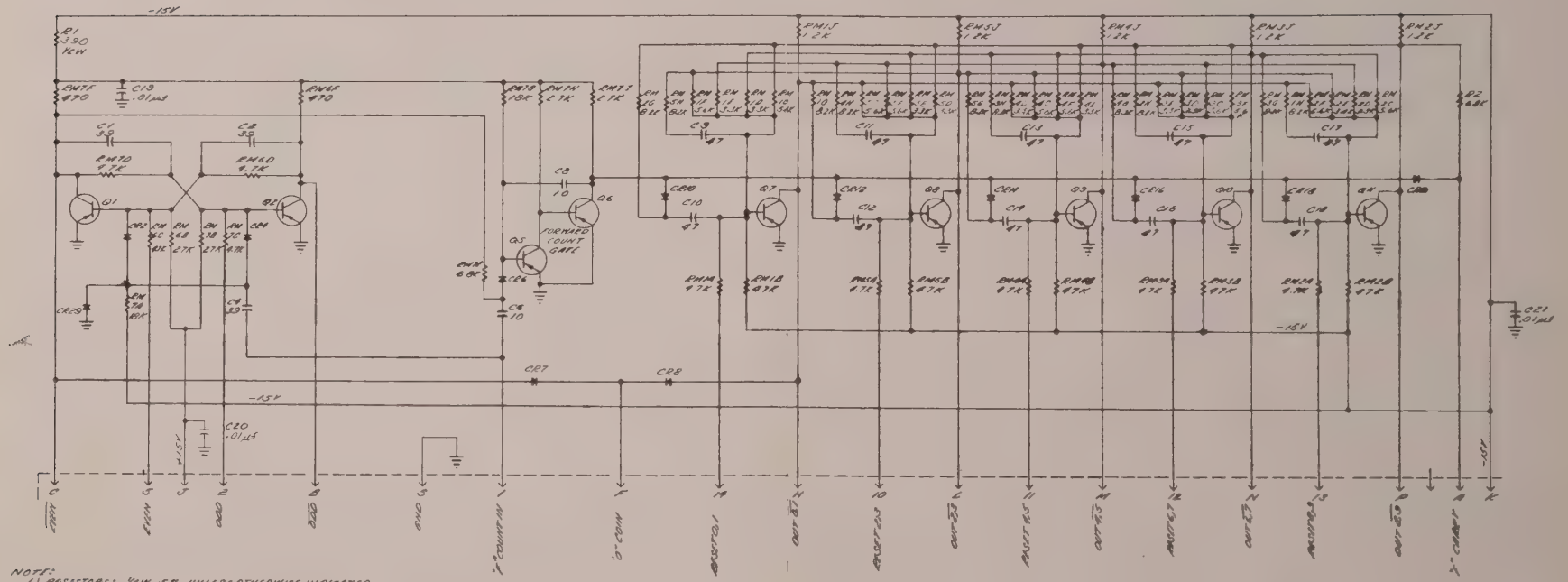
PRESET OUTPUT
SCHEMATIC DIAGRAM

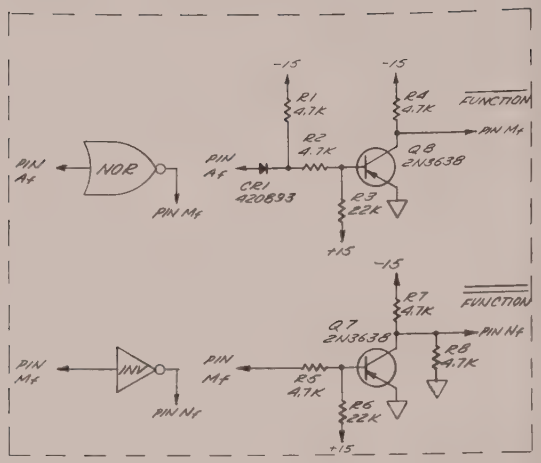


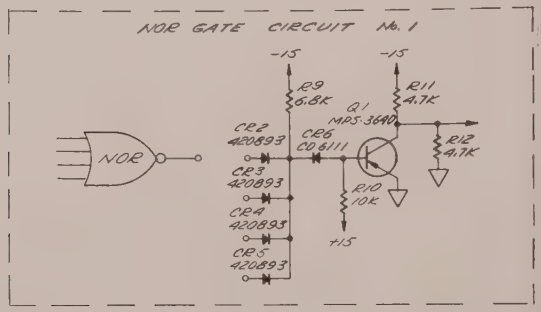
NOTE:
1.) RESISTORS —— 1/4 W, 5% UNLESS OTHERWISE NOTED.
2.) CAPACITORS —— IN μf " " "
3.) TRANSISTORS — 426735 " " "
4.) DIODES * —— 420893
DIODES ** —— CD 6111

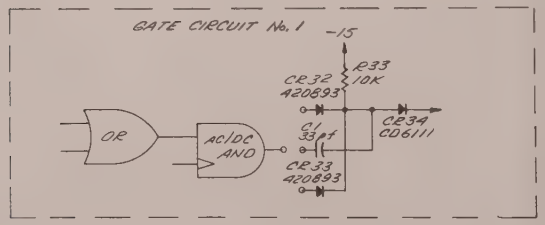
R-29
C-14
CR-10
Q-7

BI-QUINARY DCU with READOUT
FORWARD - ONLY
SCHEMATIC DIAGRAM


-15V
R1 3.9Ω 1cw
RM7E 470
C19 .01μF
RM6E 470
RM7B 18K
RM1N 2.7K
RM1T 2.7K
RM1J 1.2K
RM5J 1.2K
RM4J 1.2K
RM3J 1.2K
RM2J 1.2E
R2 68K
C1 39
C2 39
RM7D 4.7K
RM6D 4.7K
Q1
Q2
C8 10
Q6
FORWARD COUNT GATE
Q5
CR26
RM1R 6.8K
C6 10
CR29
RM7A 18K
C4 .39
C20 .01μF
CR7
CR8
C9 .47
C11 .47
C13 .47
C15 .47
C17 .47
CR10
C10 .47
Q7
CR12
C12 .47
Q8
CR14
C14 .47
Q9
CR16
C16 .47
Q10
CR18
C18 .47
Q11
CR20
RM1M 4.7K
RM1B 47K
RM5A 4.7K
RM5B 47K
RM4A 4.7K
RM4B 47K
RM3A 4.7K
RM3B 47K
RM2A 4.7K
RM2B 47K
C21 .01μF
-15V
-15V
-15V
-15V
+15V
+15V
+



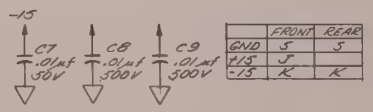




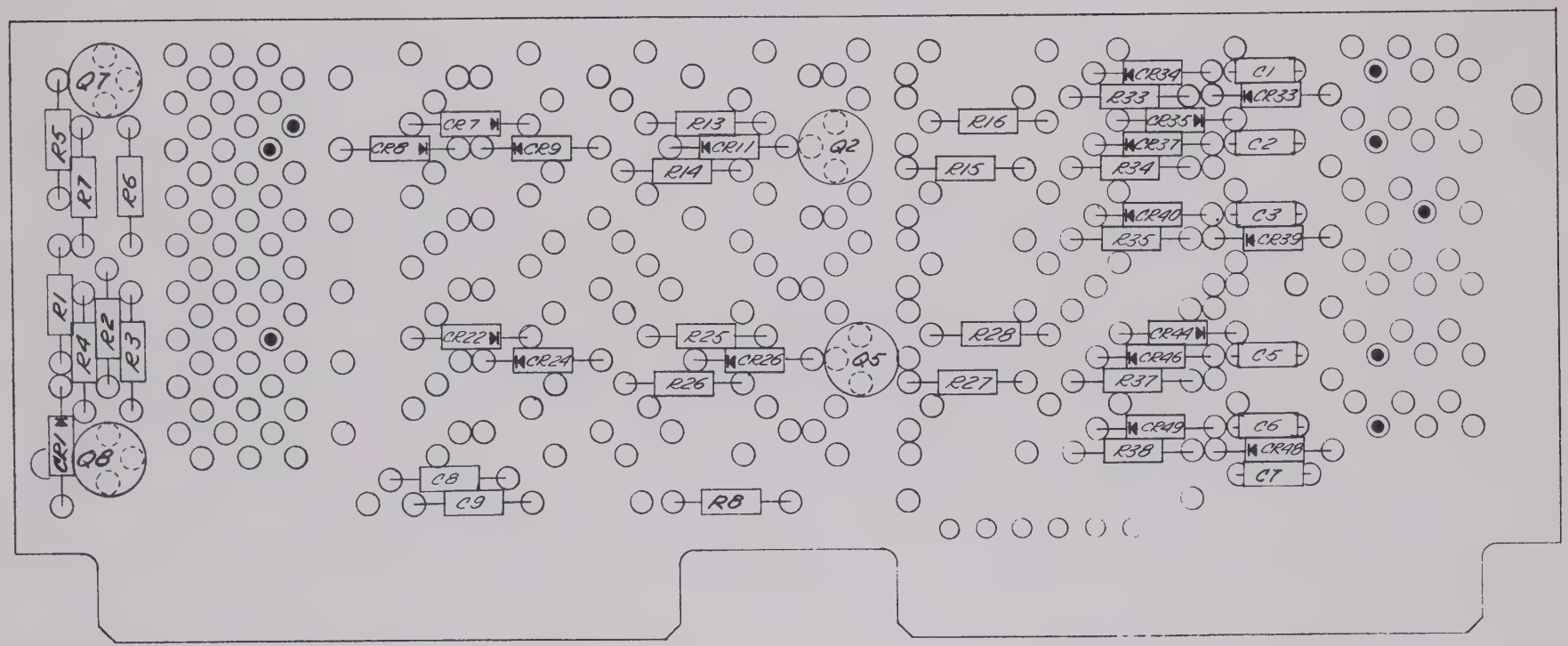
NOR GATE CIRCUIT No 2	NOR GATE CIRCUIT No. 3	NOR GATE CIRCUIT No. 4	NOR GATE CIRCUIT No 5	NOR GATE CIRCUIT No. 6
IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1
Q2	Q3	Q4	Q5	Q6
R13 THRU R16	R17 THRU R20	R21 THRU R24	R25 THRU R28	R29 THRU R32
CR7 THRU CR11	CR12 THRU CR16	CR17 THRU CR21	CR22 THRU CR26	CR27 THRU CR31

GATE CIRCUIT No. 2	GATE CIRCUIT No. 3	GATE CIRCUIT No. 4	GATE CIRCUIT No. 5	GATE CIRCUIT No. 6
IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1	IDENTICAL TO CIRCUIT No. 1
R34	R35	R36	R37	R38
C2	C3	C4	C5	C6
CR35 THRU CR37	CR38 THRU CR40	CR41 THRU CR43	CR44 THRU CR46	CR47 THRU CR49

NOTE:
1. RESISTORS— ¼ W, 5%



	FRONT	REAR
GND	S	S
+15	J	
-15	K	K

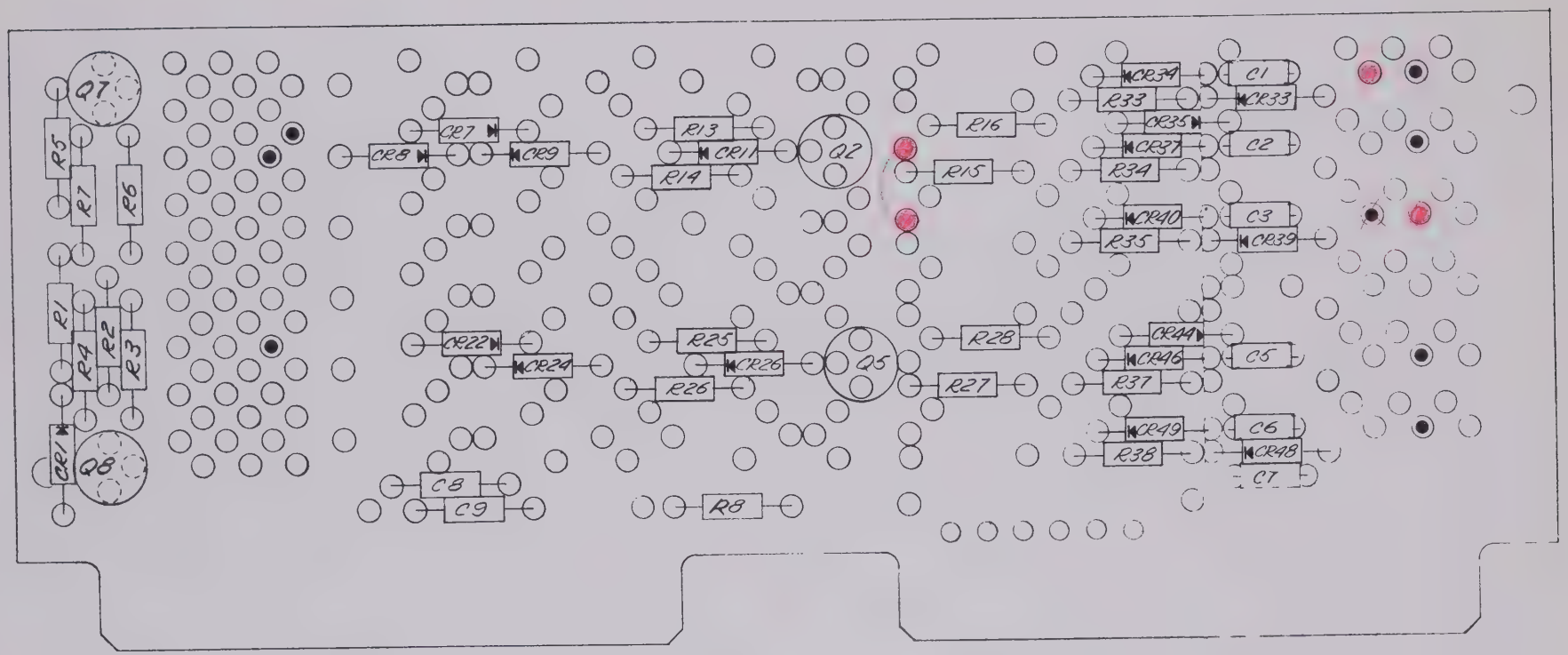


NOTE: ◉ DENOTES POSITIONS TO BE PINNED FOR FEED THROUGH.

"EPUT" FUNCTION P.C. BOARD

Model 6020
D425479-Rev. A
September 1965

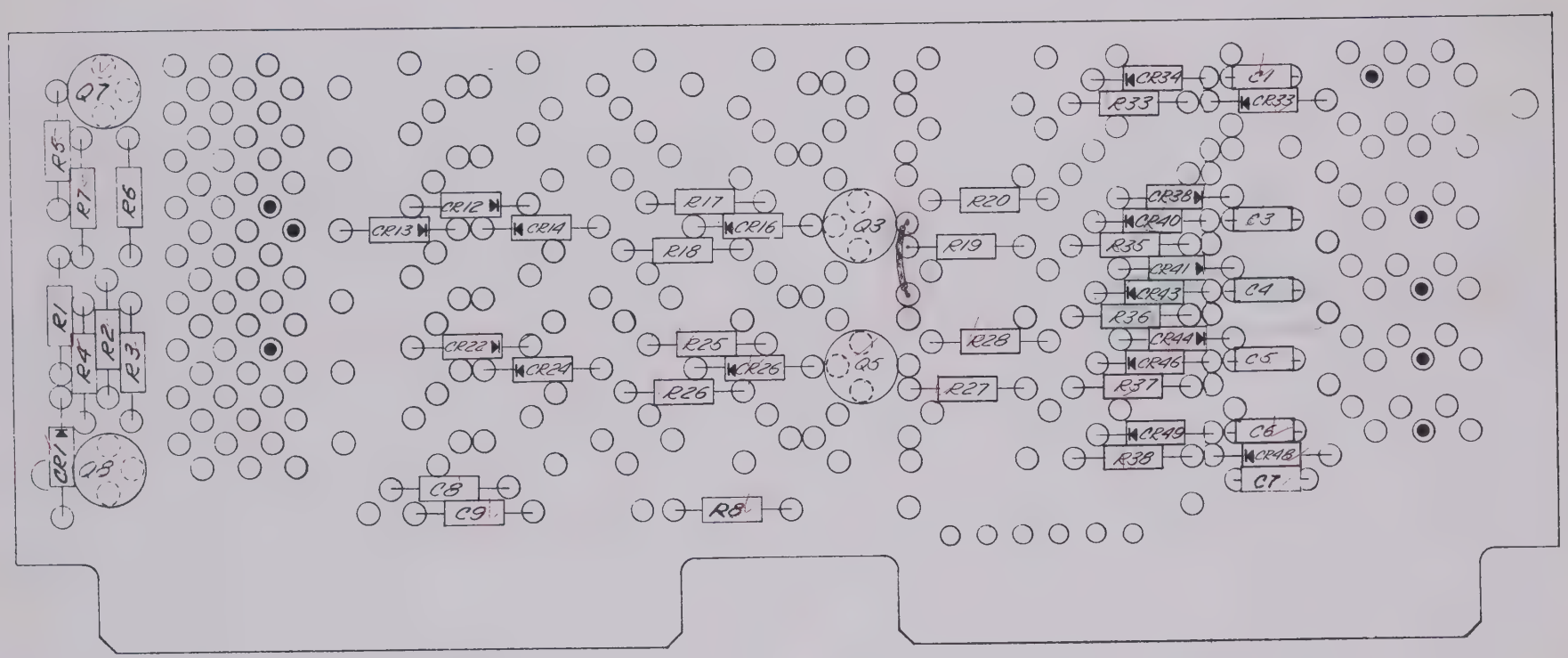
Beckman®



NOTE: ◉ DENOTES POSITION TO BE PINNED FOR FEED THROUGH.

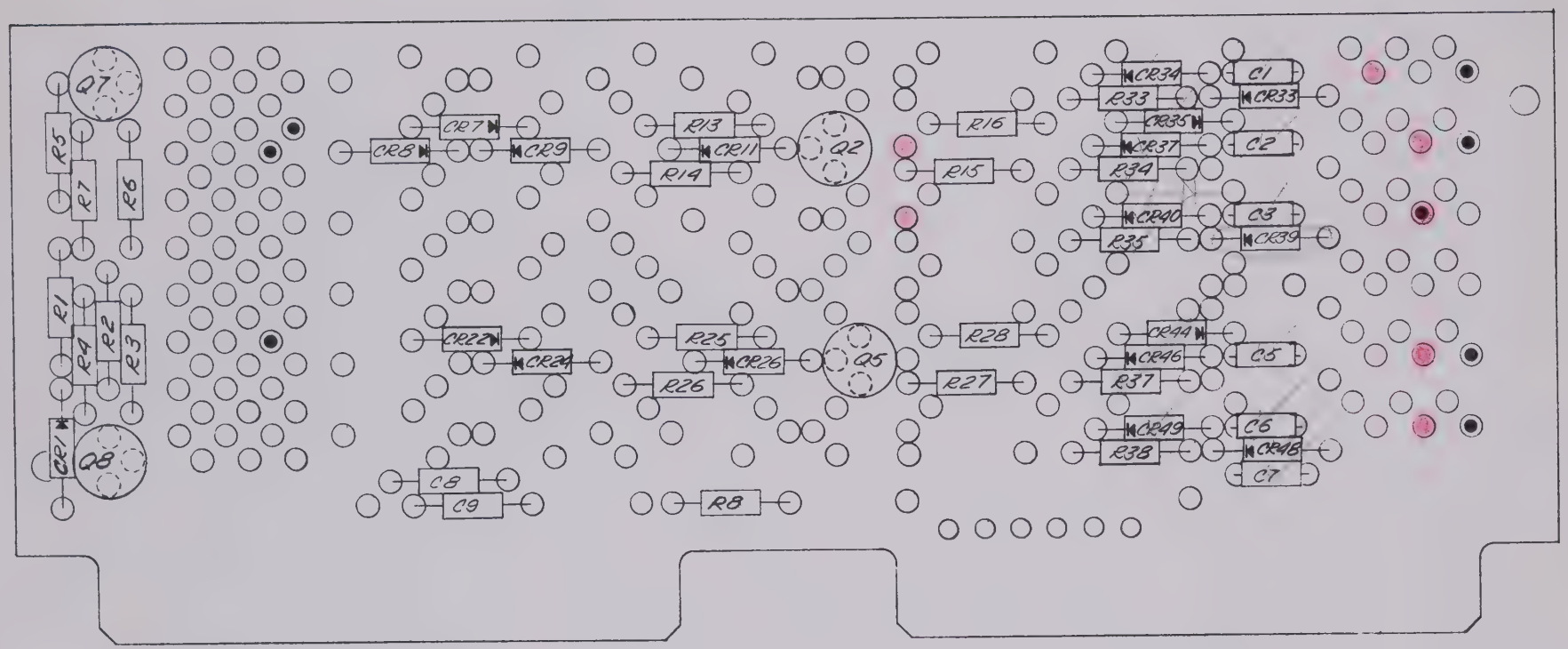
"PERIOD" FUNCTION P.C. BOARD

Model 6020
D 42481-Rev. A
September 1965
Beckman



NOTE: ◉ DENOTES POSITIONS TO BE PINNED FOR FEED THROUGH.

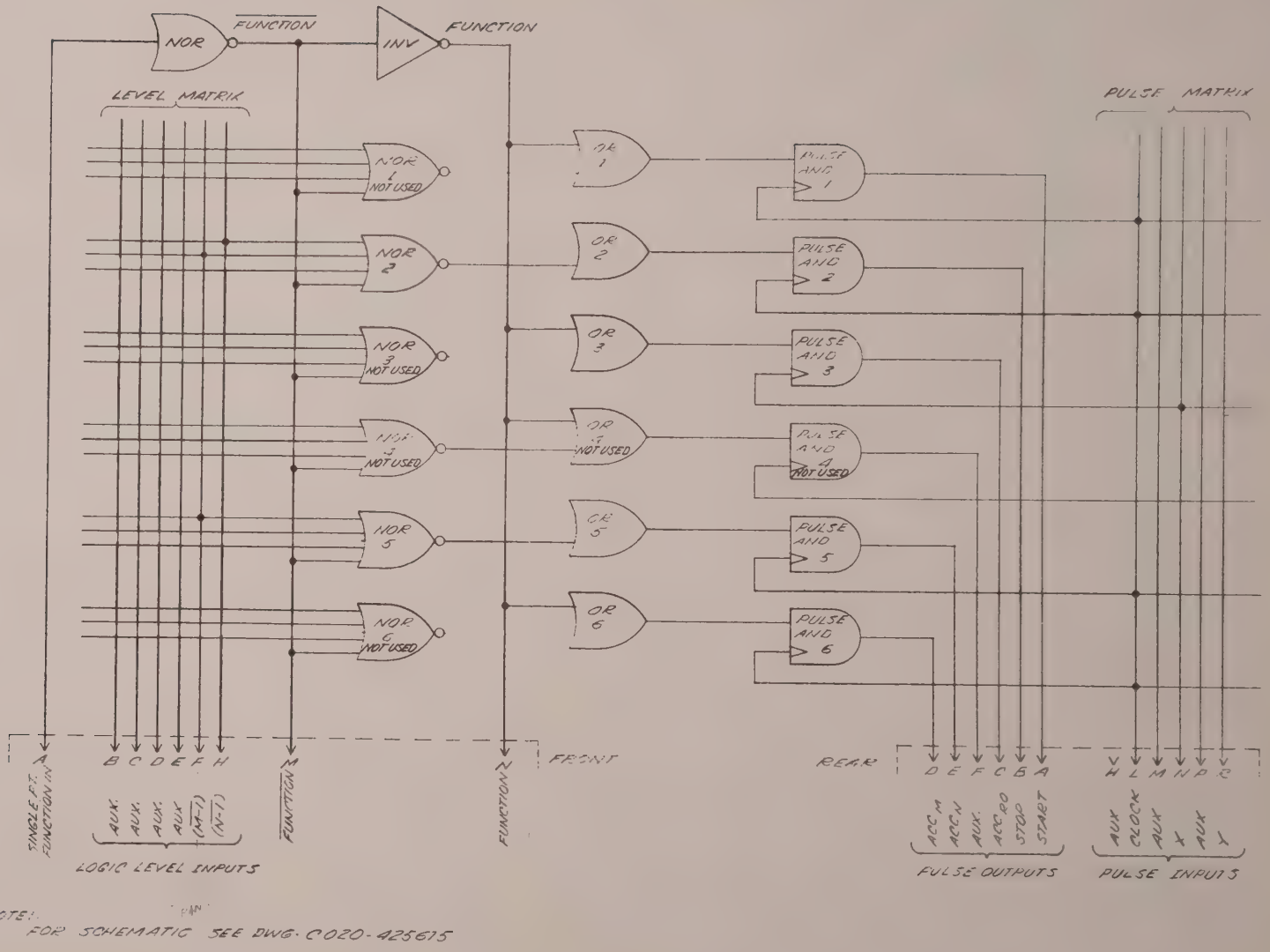
"COUNT" FUNCTION P.C. BOARD



NOTE: ◉ DENOTES POSITYIONS TO BE PINNED FOR FEED THROUGH.

"RATIO" FUNCTION P.C. BOARD

"EPUT" FUNCTION BOARD
LOGIC DIAGRAM



NOTE: FOR SCHEMATIC SEE DWG. C020-425615

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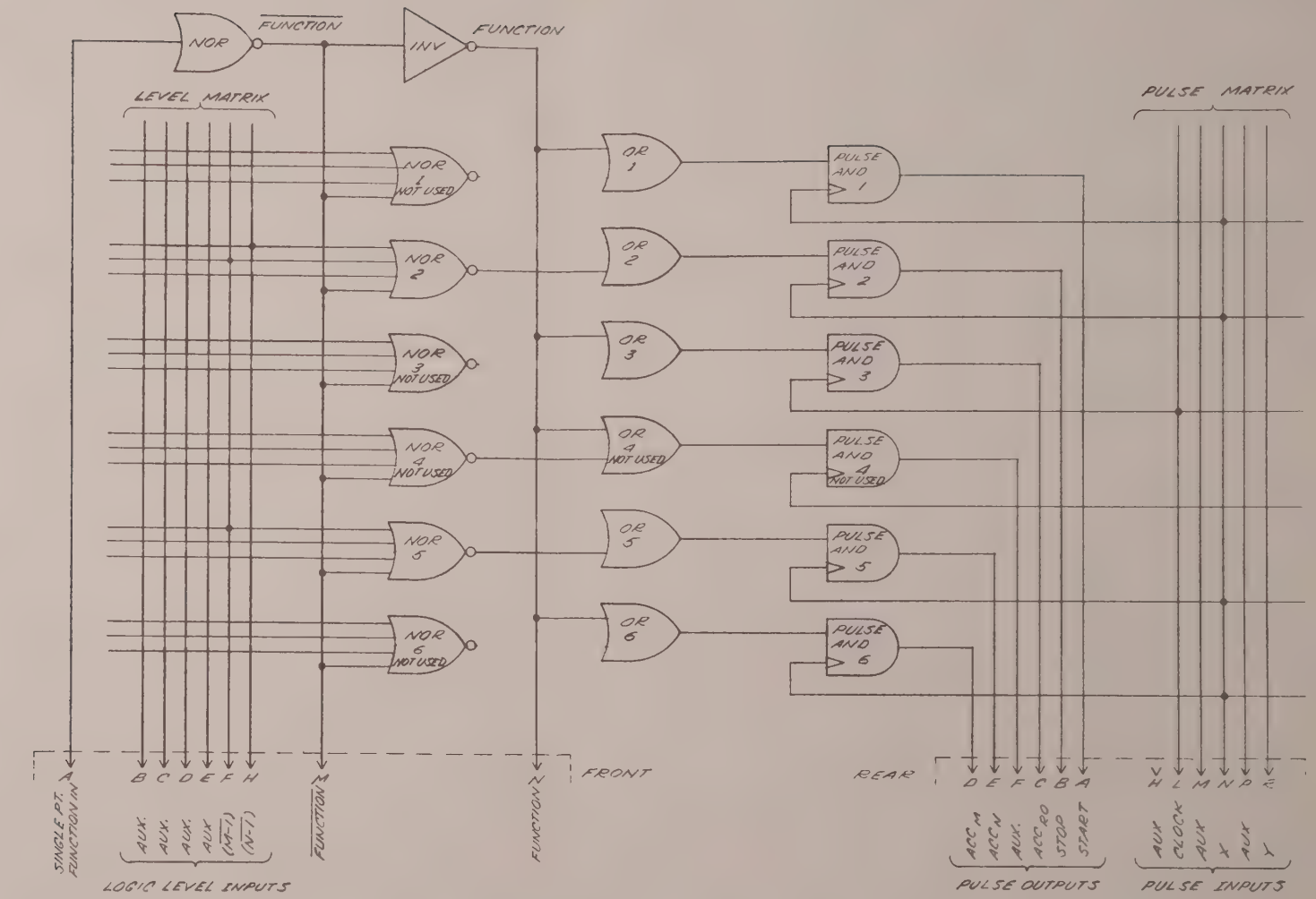
"PERIOD" FUNCTION BOARD
LOGIC DIAGRAM



NOTE:
FOR SCHEMATIC SEE DWG. C020-425615

Model 6020
C 425618-Rev. A
September 1965

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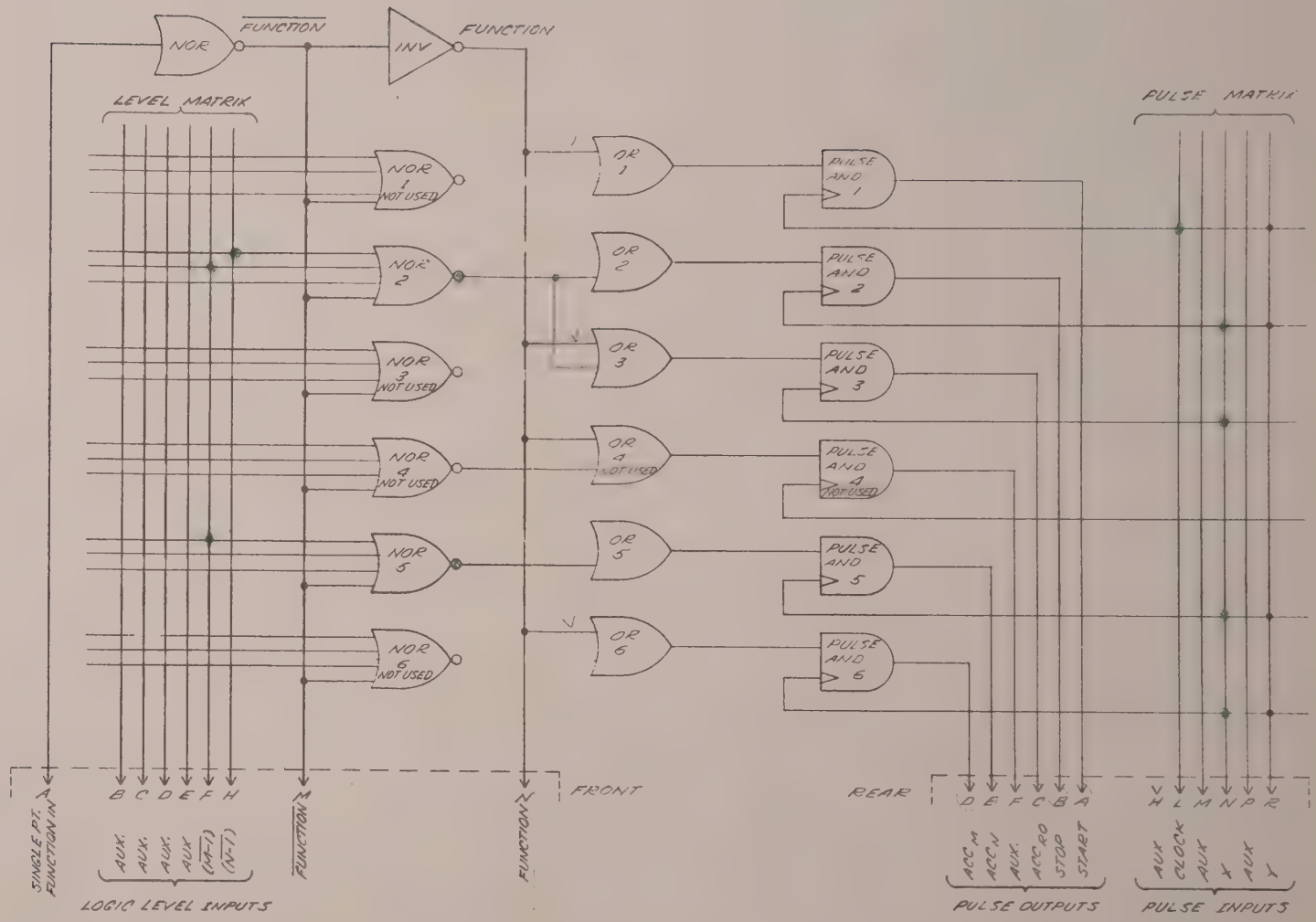
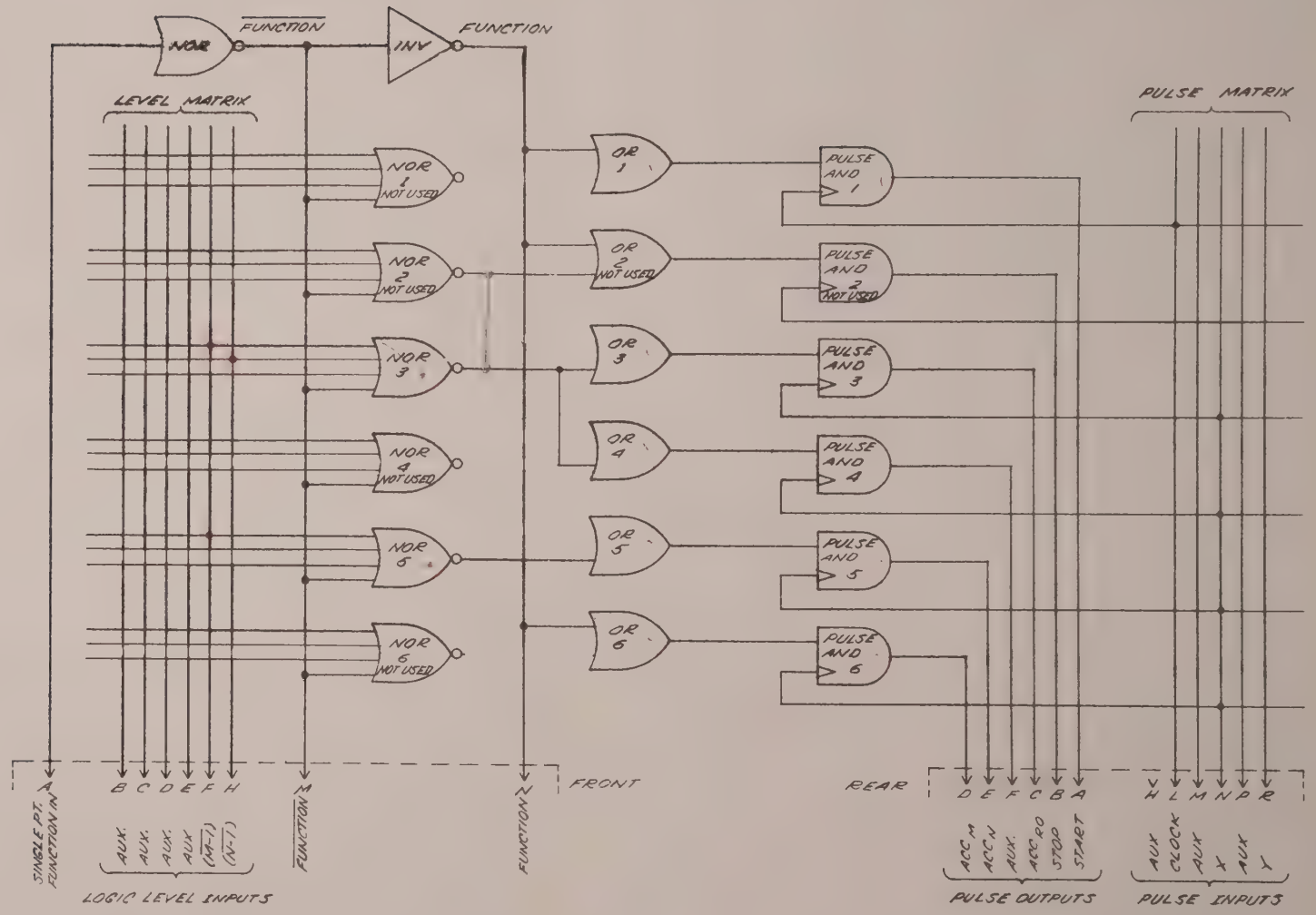
CHANGE TO COUNT

"RATIO" FUNCTION BOARD
LOGIC DIAGRAM



NOTE:
FOR SCHEMATIC SEE DWG. C020-425615

"COUNT" FUNCTION BOARD
LOGIC DIAGRAM



NOTE:
FOR SCHEMATIC SEE DWG. C020-425615

Model 8020
C 425620-Rev. A
September 1965

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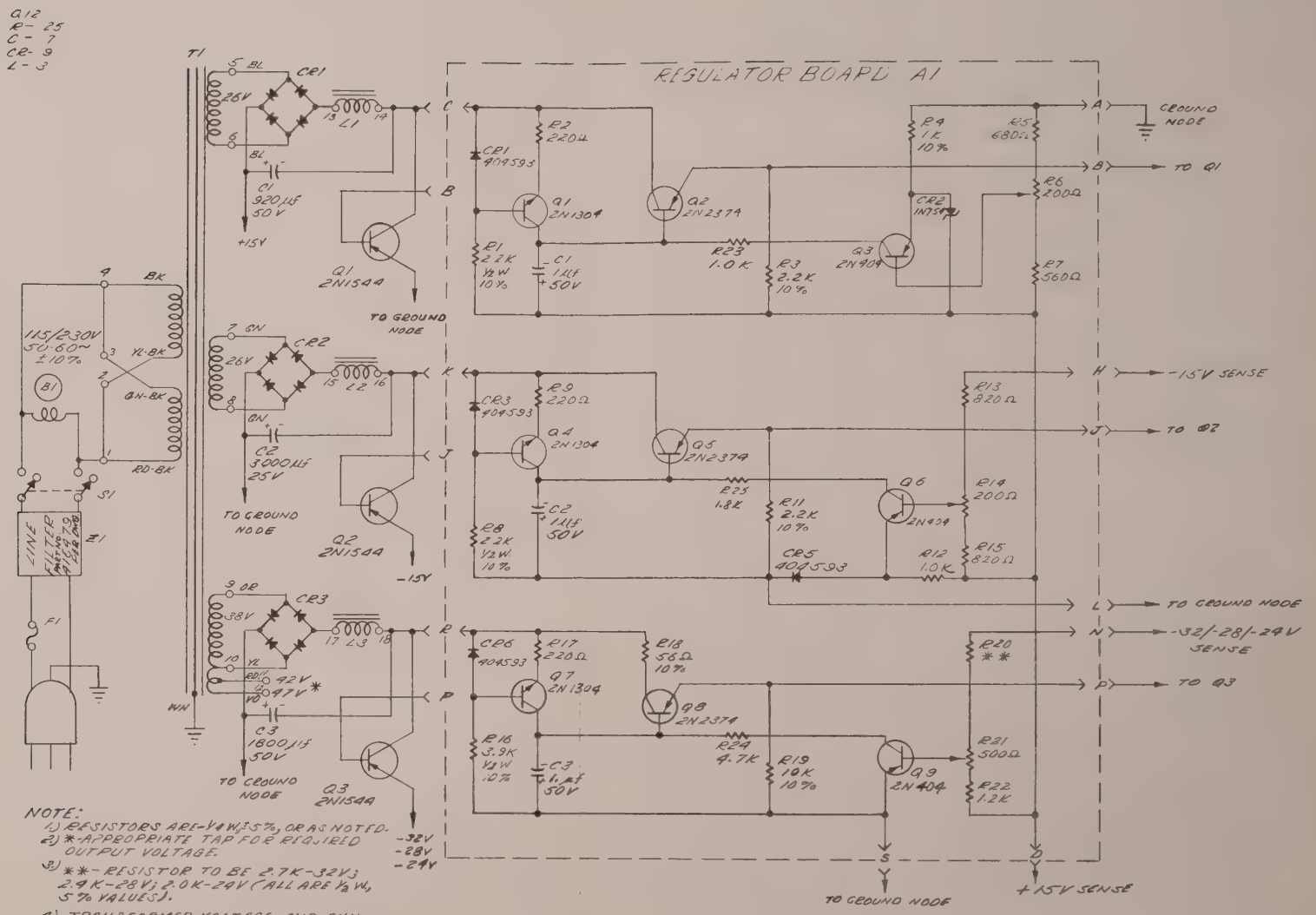
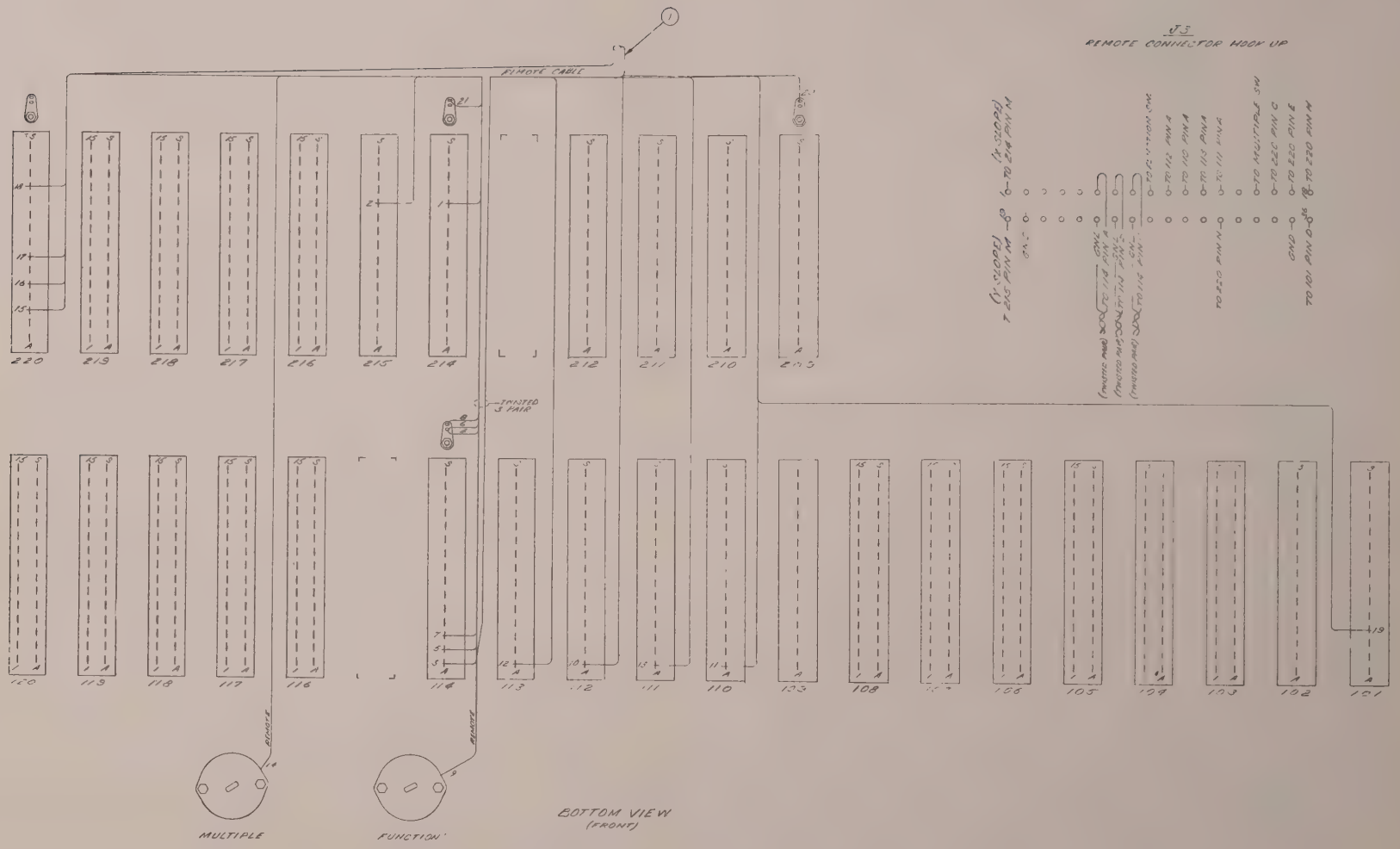

Q12
R- 25
C- 7
CR- 9
L- 3
REGULATOR BOARD A1
T1
CR1
CR2
CR3
Q1 2N1544
Q2 2N1544
Q3 2N1544
Q1 2N1304
Q2 2N2374
Q3 2N404
Q4 2N1304
Q5 2N2374
Q6 2N404
Q7 2N1304
Q8 2N2374
Q9 2N404
115/230V 50-60~ ±10%
LINE FILTER
S1
F1
C1 920 µF 50V
C2 3000 µF 25V
C3 1800 µF 50V
+15V
-15V
-32V
-28V
-24V
TO GROUND NODE
GROUND NODE
TO Q1
TO Q2
TO Q3
-15V SENSE
-32/-28/-24V SENSE
+15V SENSE
NOTE:
1) RESISTORS ARE-½W, 5%, OR AS NOTED.
2) *-APPROPRIATE TAP FOR REQUIRED OUTPUT VOLTAGE.
3) **-RESISTOR TO BE 2.7K-32V; 2.4K-28V; 2.0K-24V (ALL ARE ½W, 5% VALUES).
4) TRANSFORMER VOLTAGE AND FULL REGULATION IS LESS THAN 10%.
5) TRANSISTORS; 1, 2, & 3 ARE MOUNTED ON HEAT SINK

REMOTE CONNECTOR WIRING DIAGRAM



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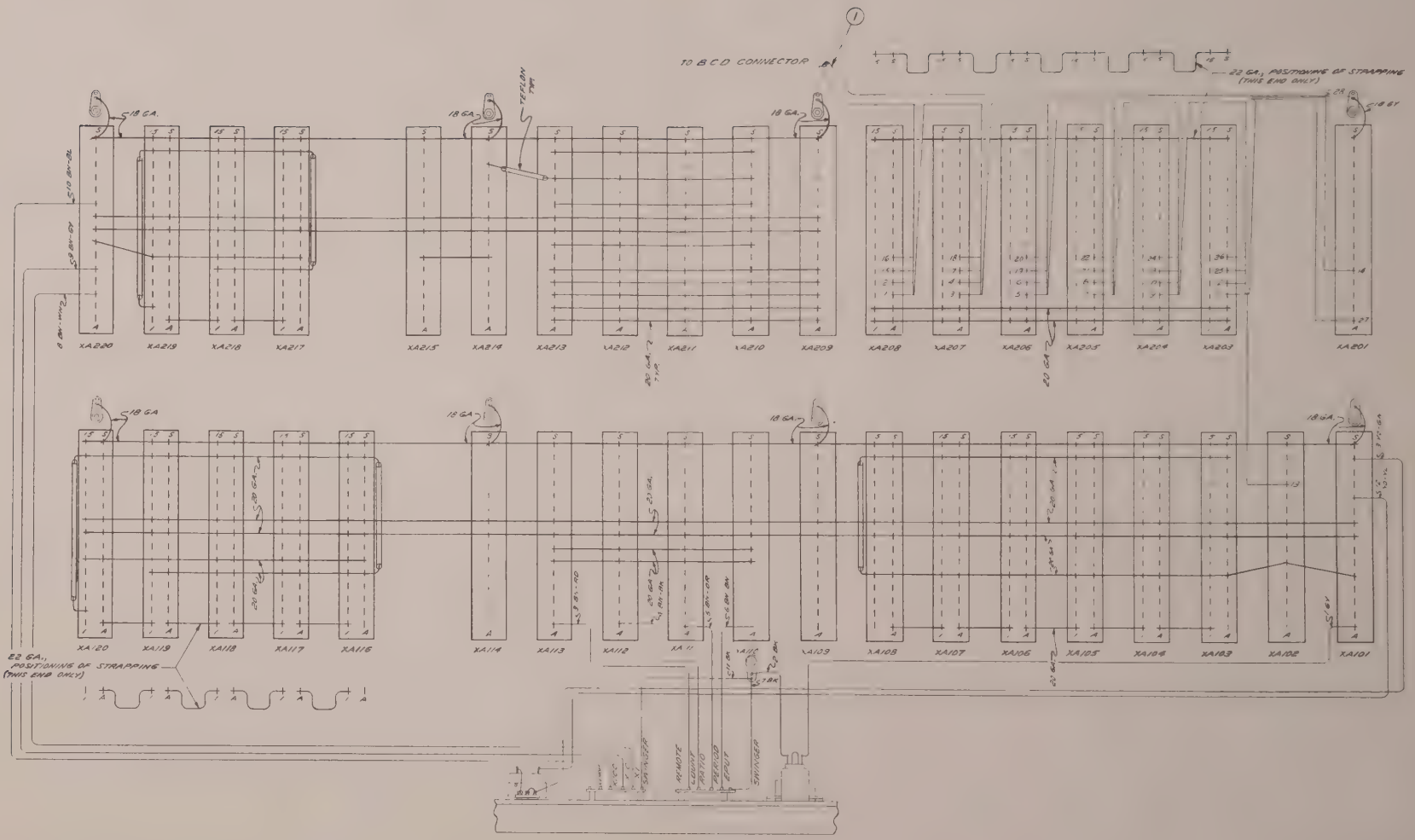
BCD & SWITCH STRAPPING WIRING DIAGRAM



Model 6020
D-625276-Rev. A
September 1965

Beckman

BECKMAN INSTRUMENTS, INC., BERKELEY DIVISION

EASTERN REGIONAL OFFICES

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Mountainside, New Jersey 07091
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BArclay 7-7233 -- New York
(area code 212)
TWX: 201-233-1343

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Montgomery Industrial Park
Silver Spring, Maryland
Phone: 622-2500 (area code 301)

1 Bala Avenue
Bala Cynwyd, Pennsylvania 19004
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NOTE

Factory repair facility is located at the Mountainside office.

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TWX: 617-734-4498

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New Haven, Connecticut 06515
Phone: SPruce 7-6279 (area code 203)

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Marine and Land Communications Division
Electronic Instruments Department
2442 Trenton Avenue
Montreal 16, Quebec, Canada
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TWX: 610-421-3564

DANNEMILLER-SMITH, INC.:

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Houston, Texas 77027
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TWX: 713-571-1083

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TWX: 314-556-0545

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Orlando, Florida 32804
Phone: GArden 4-2167 or GArden 4-5633
(area code 305)
TWX: 305-275-0646

2110 Peachtree Road, N.W.
Atlanta, Georgia 30309
Phone: TRinity 6-3020 (area code 404)
TWX: 404-257-1149

1106 Burke Street
Winston-Salem, North Carolina 27101
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(area code 919)
TWX: 919-725-6493

904 Bob Wallace Ave., Room 114
Huntsville, Alabama 35801
Phone: 536-9121 or 539-8476 (area code 205)
TWX: 205-533-1426

continued. . .

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TWX: 315-477-1090

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Phone: 732-1801 (area code 315)

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Poughkeepsie, New York 12603
Phone: 914/462-2730

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Berkley, Michigan 48072
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5249 Broadview Road
Cleveland, Ohio 44134
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TWX: 810-421-8300

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TWX: 810-341-3213

2400 E. Dorothy Lane
Dayton, Ohio 45420
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TWX: 513-944-0390

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Minneapolis, Minnesota 55423
Phone: 866-3305 (area code 612)
TWX: 910-576-2885

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Los Angeles, California 90026
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TWX: 213-380-8840

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Los Altos, California 94022
Phone: WHitecliff 8-1483
TWX: 415-949-7950

3445 Fifth Avenue
San Diego, California 92103
Phone: CYpress 8-9835 (area code 714)
TWX: 714-291-0736

9611 Acoma Road, S.E.
Albuquerque, New Mexico 87112
Phone: 298-5589 or 298-5580 (area code 505)
TWX: 505-243-8409

3707 West Ruth
Phoenix, Arizona 85021
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